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SERVICE MANUAL

BEDSIDE MONITOR

BSM-2300A/C/K

0634-001878G

NIHON KOHDEN

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GENERAL HANDLING PRECAUTIONS

This device is intended for use only by qualified medical personnel.
Use only Nihon Kohden approved products with this device. Use of non-approved products or in a non-approved manner may affect the performance specifications of the device. This includes, but is not limited to, batteries, recording paper, pens, extension cables, electrode leads, input boxes and AC power.

Please read these precautions thoroughly before attempting to operate the instrument.

1. **To safely and effectively use the instrument, its operation must be fully understood.**

2. **When installing or storing the instrument, take the following precautions:**
   (1) Avoid moisture or contact with water, extreme atmospheric pressure, excessive humidity and temperatures, poorly ventilated areas, and dust, saline or sulphuric air.
   (2) Place the instrument on an even, level floor. Avoid vibration and mechanical shock, even during transport.
   (3) Avoid placing in an area where chemicals are stored or where there is danger of gas leakage.
   (4) The power line source to be applied to the instrument must correspond in frequency and voltage to product specifications, and have sufficient current capacity.
   (5) Choose a room where a proper grounding facility is available.

3. **Before Operation**
   (1) Check that the instrument is in perfect operating order.
   (2) Check that the instrument is grounded properly.
   (3) Check that all cords are connected properly.
   (4) Pay extra attention when the instrument is combined with other instruments to avoid misdiagnosis or other problems.
   (5) All circuitry used for direct patient connection must be doubly checked.
   (6) Check that battery level is acceptable and battery condition is good when using battery-operated models.

4. **During Operation**
   (1) Both the instrument and the patient must receive continual, careful attention.
   (2) Turn power off or remove electrodes and/or transducers when necessary to assure the patient's safety.
   (3) Avoid direct contact between the instrument housing and the patient.

5. **To Shutdown After Use**
   (1) Turn power off with all controls returned to their original positions.
   (2) Remove the cords gently; do not use force to remove them.
   (3) Clean the instrument together with all accessories for their next use.

6. **The instrument must receive expert, professional attention for maintenance and repairs. When the instrument is not functioning properly, it should be clearly marked to avoid operation while it is out of order.**

7. **The instrument must not be altered or modified in any way.**

8. **Maintenance and Inspection:**
   (1) The instrument and parts must undergo regular maintenance inspection at least every 6 months.
   (2) If stored for extended periods without being used, make sure prior to operation that the instrument is in perfect operating condition.

(3) Technical information such as parts list, descriptions, calibration instructions or other information is available for qualified user technical personnel upon request from your Nihon Kohden distributor.

9. When the instrument is used with an electrosurgical instrument, pay careful attention to the application and/or location of electrodes and/or transducers to avoid possible burn to the patient.

10. When the instrument is used with a defibrillator, make sure that the instrument is protected against defibrillator discharge. If not, remove patient cables and/or transducers from the instrument to avoid possible damage.

WARRANTY POLICY

Nihon Kohden Corporation (NKC) shall warrant its products against all defects in materials and workmanship for one year from the date of delivery. However, consumable materials such as recording paper, ink, stylus and battery are excluded from the warranty.

NKC or its authorized agents will repair or replace any products which prove to be defective during the warranty period, provided these products are used as prescribed by the operating instructions given in the operator's and service manuals.

No other party is authorized to make any warranty or assume liability for NKC's products. NKC will not recognize any other warranty, either implied or in writing. In addition, service, technical modification or any other product change performed by someone other than NKC or its authorized agents without prior consent of NKC may be cause for voiding this warranty.

Defective products or parts must be returned to NKC or its authorized agents, along with an explanation of the failure. Shipping costs must be pre-paid.

This warranty does not apply to products that have been modified, disassembled, reinstalled or repaired without Nihon Kohden approval or which have been subjected to neglect or accident, damage due to accident, fire, lightning, vandalism, water or other casualty, improper installation or application, or on which the original identification marks have been removed.

In the USA and Canada other warranty policies may apply.

CAUTION

United States law restricts this device to sale by or on the order of physician.

EMC RELATED CAUTION

This equipment and/or system complies with IEC 60601-2 International Standard for electromagnetic compatibility for medical electrical equipment and/or system. However, an electromagnetic environment that exceeds the limits or levels stipulated in IEC 60601-1-2, can cause harmful interference to the equipment and/or system or cause the equipment and/or system to fail to perform its intended function or degrade its intended performance. Therefore, during the operation of the equipment and/or system, if there is any undesired deviation from its intended operational performance, you must avoid, identify and resolve the adverse electromagnetic effect before continuing to use the equipment and/or system.

The following describes some common interference sources and remedial actions:

1. **Strong electromagnetic interference from a nearby emitter source such as an authorized radio station or cellular phone:**
   Install the equipment and/or system at another location. Keep the emitter source such as cellular phone away from the equipment and/or system, or turn off the cellular phone.

2. **Radio-frequency interference from other equipment through the AC power supply of the equipment and/or system:**
   Identify the cause of this interference and if possible remove this interference source. If this is not possible, use a different power supply.

3. **Effect of direct or indirect electrostatic discharge:**
   Make sure all users and patients in contact with the equipment and/or system are free from direct or indirect electrostatic energy before using it. A humid room can help lessen this problem.

4. **Electromagnetic interference with any radio wave receiver such as radio or television:**
   If the equipment and/or system interferes with any radio wave receiver, locate the equipment and/or system as far as possible from the radio wave receiver.

5. **Interference of lightning**
   When lightning occurs near the location where the equipment and/or system is installed, it may induce an excessive voltage in the equipment and/or system. In such a case, disconnect the AC power cord from the equipment and/or system and operate the equipment and/or system by battery power, or use an uninterruptible power supply.

6. **Use with other equipment**
   When the equipment and/or system is adjacent to or stacked with other equipment, the equipment and/or system may affect the other equipment. Before use, check that the equipment and/or system operates normally with the other equipment.

7. **Use of unspecified accessory, transducer and/or cable**
   When an unspecified accessory, transducer and/or cable is connected to this equipment and/or system, it may cause increased electromagnetic emission or decreased electromagnetic immunity. The specified configuration of this equipment and/or system complies with the electromagnetic requirements with the specified configuration. Only use this equipment and/or system with the specified configuration.

Caution - continued

8. **Use of unspecified configuration**
   When the equipment and/or system is used with the unspecified system configuration different than the configuration of EMC testing, it may cause increased electromagnetic emission or decreased electromagnetic immunity. Only use this equipment and/or system with the specified configuration.

9. **Measurement with excessive sensitivity**
   The equipment and/or system is designed to measure bioelectrical signals with a specified sensitivity. If the equipment and/or system is used with excessive sensitivity, artifact may appear by electromagnetic interference and this may cause mis-diagnosis. When unexpected artifact appears, inspect the surrounding electromagnetic conditions and remove this artifact source.

If the above suggested remedial actions do not solve the problem, consult your Nihon Kohden distributor or representative for additional suggestions.

The CE mark is a protected conformity mark of the European Community. The products herewith comply with the requirements of the Medical Device Directive 93/42/EEC.

The CE mark only applies to the BSM-2300K bedside monitor.

NOTE about Waste Electrical and Electronic Equipment (WEEE) directive 2002/96/EEC
For the member states of the European Union only:
The purpose of WEEE directive 2002/96/EEC is, as a first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste.
Contact your Nihon Kohden representative for disposal at the end of its working life.

When measuring SpO_2, various interference may produce false waveforms which look like pulse waveforms. SpO_2 value and pulse rate may be measured from these false waveforms, causing the alarm to function improperly.

When installing the monitor, avoid locations where the monitor may receive strong electromagnetic interference such as radio or TV stations, cellular phone or mobile two-way radios.

WARNING

Interaction Between Minute Ventilation Rate-Adaptive Pacemakers and Cardiac Monitoring and Diagnostic Equipment*

The bioelectric impedance measurement sensor of a minute ventilation rate-adaptive implantable pacemaker may be affected by cardiac monitoring and diagnostic equipment which is connected to the same patient. If this occurs, the pacemaker may pace at its maximum rate and give incorrect data to the monitor or diagnostic equipment. If this occurs, disconnect the monitor or diagnostic equipment from the patient or change the setting on the pacemaker by referring to the pacemaker's manual. For more details, contact your pacemaker distributor or Nihon Kohden distributor.

* Minute ventilation is sensed in rate-adaptive pacemakers by a technology known as bioelectric impedance measurement (BIM). Many medical devices in addition to pacemakers use this technology. When one of these devices is used on a patient with an active, minute ventilation rate-adaptive pacemaker, the pacemaker may erroneously interpret the mixture of BIM signals created in the patient, resulting in an elevated pacing rate.

  For more information, see the FDA web site.
  http://www.fda.gov/cdrh/safety.html

Conventions Used in this Manual and Instrument

Warnings, Cautions and Notes

Warnings, cautions and notes are used in this manual to alert or signal the reader to specific information.

WARNING

A warning alerts the user to the possible injury or death associated with the use or misuse of the instrument.

CAUTION

A caution alerts the user to possible injury or problems with the instrument associated with its use or misuse such as instrument malfunction, instrument failure, damage to the instrument, or damage to other property.

NOTE

A note provides specific information, in the form of recommendations, prerequirements, alternative methods or supplemental information.

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Introduction

This service manual provides useful information to qualified personnel to understand, troubleshoot, service, maintain and repair the BSM-2300 bedside monitor (referred to as “the instrument” in this service manual).

All replaceable parts or units of this instrument are clearly listed with exploded illustration to help you locate the parts quickly.

The “Maintenance” section in this service manual describes the maintenance that should be performed by qualified service personnel. The “Maintenance” section in the operator’s manual describes the maintenance that can be performed by the user.

The information in the operator’s manual is primarily for the user. However, it is important for service personnel to thoroughly read the operator’s manual and service manual before starting to troubleshoot, service, maintain or repair this instrument. This is because service personnel need to understand the operation of the instrument in order to effectively use the information in the service manual.

General Information on Servicing

Note the following information when servicing the instrument.

CAUTION

Safety

- **There is the possibility that the outside surface of the instrument, such as the operation keys, could be contaminated by contagious germs, so disinfect and clean the instrument before servicing it. When servicing the instrument, wear rubber gloves to protect yourself from infection.**
- **There is the possibility that when the lithium battery is broken, a solvent inside the lithium battery could flow out or a toxic substance inside it could come out. If the solvent or toxic substance touches your skin or gets into your eye or mouth, immediately wash it with a lot of water and see a physician.**

Liquid Ingress

The instrument is not drip-proof, so do not install the instrument where water or liquid can get into or fall on the instrument. If liquid accidentally gets into the instrument or the instrument accidentally drops into liquid, disassemble the instrument, clean it with clean water and dry it completely. After reassembling, verify that there is nothing wrong with the patient safety checks and function/performance checks. If there is something wrong with the instrument, contact your Nihon Kohden representative to repair.

Environmental Safeguards

Depending on the local laws in your community, it may be illegal to dispose of the lithium battery and CRT unit in the regular waste collection. Check with your local officials for proper disposal procedures.

Disinfection and Cleaning

To disinfect the outside surface of the instrument, wipe it with a non-abrasive cloth moistened with any of the disinfectants listed below. Do not use any other disinfectants or ultraviolet rays to disinfect the instrument.

- **Chlorohexidine gluconate solution: 0.5%**
- **Benzethonium chloride solution: 0.2%**
- **Glutaraldehyde solution: 2.0%**
- **Benzalkonium chloride: 0.2%**
- **Hydrochloric alkyldiaminoethylglycine: 0.5%**

Transport

- **Use the specified shipment container and packing material to transport the instrument. If necessary, double pack the instrument. Also, put the instrument into the shipment container after packing so that the buffer material does not get into the inside of the instrument.**
- **When transporting the board or unit of the instrument, be sure to use a conductive bag. Never use an aluminum bag when transporting the power board, power unit or board on which a lithium battery is mounted. Also, never use a styrene foam or plastic bag which generates static electricity to wrap the board or unit of the instrument.**

Handling the Instrument

- **Because the outside surface of the instrument is made of resin, the outside surface of the instrument is easily damaged. So when handling the instrument, remove clutter from around the instrument and be careful to not damage the instrument or get it dirty.**
- **Because most of the boards in the instrument are multilayer boards with surface mounted electrical devices (SMD), when removing and soldering the electrical devices, a special tool is required. To avoid damaging other electrical components, do not remove and solder SMD components yourself.**

Measuring and Test Equipment

Maintain the accuracy of the measuring and test equipment by checking and calibrating it according to the check and calibration procedures.

Service Policy, Service Parts and Patient Safety Checks

Service Policy

Our technical service policy for this instrument is to replace the faulty unit, board or part or damaged mechanical part with a new one. Do not perform electrical device or component level repair of the multilayer board or unit. We do not support component level repair outside the factory for the following reasons:

- Most of the boards are multilayer boards with surface mounted electrical devices, so the mounting density of the board is too high.
- A special tool or high degree of repair skill is required to repair the multilayer boards with surface mounted electrical devices.

Disassemble the instrument or replace a board or unit in an environment where the instrument is protected against static electricity.

As background knowledge for repair, pay special attention to the following:

- You can reduce the repair time by considering the problem before starting repair.
- You can clarify the source of most of the troubles using the information from the diagnostic check function of the instrument. Refer to “Diagnostic Check “ of this manual.

Service Parts

Refer to “Replaceable Parts List” of this manual for the service parts for technical service that we provide.

NOTE

When ordering parts or accessories from your Nihon Kohden representative, please quote the NK code number and part name which is listed in this service manual, and the name or model of the unit in which the required part is located. This will help us to promptly attend to your needs. Always use parts and accessories recommended or supplied by Nihon Kohden Corporation to assure maximum performance from your instrument.

Patient Safety Checks

Periodic maintenance procedures and diagnostic check procedures are provided in this manual to ensure that the instrument is operating in accordance with its design and production specifications. To verify that the instrument is working in a safe manner with regard to patient safety, patient safety checks should be performed on the instrument before it is first installed, periodically after installation, and after any repair is made on the instrument.

For patient safety checks, perform the following checks as described in the International Electrotechnical Commission's standard, IEC 60601-1:1988 :

- Protective earth resistance check
- Earth leakage current check
- Enclosure leakage current check
- Patient leakage current check
- Withstanding voltage check

Specifications

<BSM-2301/2303/2304/2351/2353>

Display

Display size:	BSM-2301/2303/2304: 8.4 inch, TFT type color LCD
	BSM-2351/2353: 10.4 inch, TFT type color LCD
Waveform display mode:	Non-fade moving or non-fade fixed
Viewing area:	BSM-2301/2303/2304: 170.4 mm × 127.8 mm
	BSM-2351/2353: 211.2 mm × 158.4 mm
Resolution:	800 × 600 dots
Maximum number of waveform trace:	BSM-2301/2351: 5 traces
	BSM-2303/2304/2353: 6 traces
Sweep speed:	25 mm/s, 50 mm/s (Respiration and CO_2 low speed: 1.56 mm/s, 6.25 mm/s)
Sweep width:	BSM-2301/2303/2304: about 124 mm at 25 mm/s sweep speed
	BSM-2351/2353: about 154 mm at 25 mm/s sweep speed
Waveform display color:	12
Numeric display color:	12
Waveform freeze:	Provided
Display waveforms:	ECG, respiration, IBP, SpO_2 pulse wave and CO_2
Numerical data display:	Heart rate, VPC rate, ST level, respiration rate, IBP (systolic, diastolic, mean), NIBP (systolic, diastolic, mean), SpO_2, pulse rate, temperature, $ETCO_2$ and $FiCO_2$
Synchronization mark:	Heart rate sync mark, pulse rate sync mark, respiratory sync mark

Sound

Sound type:	Alarm, synchronization, click
Alarm sound:	3 types
Synchronization sound:	Pitch variable for IBP and SpO_2

Alarm

Alarm items:	Upper/lower limits alarm, apnea alarm, arrhythmia alarm, connector disconnection alarm, noise alarm, electrode off alarm, pulse waveform detecting alarm, probe off alarm, cuff/hose check alarm, sensor check alarm, battery weak alarm, operating environment alarm
Alarm levels:	Crisis (red blinking), Warning (yellow blinking), Advisory (yellow lighting)
Alarm indication:	Alarm indicator, highlighted message, alarm sound
Alarm suspend:	Provided (for 1 or 2 min)

ECG

Electrode offset potential tolerance:	±500 mV
Input dynamic range:	± 5 mV
Internal noise:	≤30 μVp-p (Refer to input)
Common mode rejection ratio:	≥95 dB
Input impedance	≥5 MΩ (at 10 Hz)
Input bias current:	≤100 nA
Heart rate count	
Calculation method:	Moving average/Instantaneous beat to beat (selectable)
Counting range:	0, 12 to 300 beats/min (±2 beats/min)

Arrhythmia analysis	
Analysis method:	Template matching method
Number of channels:	1 channel
VPC counting rate:	0 to 99 VPCs/min
Arrhythmia message:	ASYSTOLE, VT, VF, VPC RUN, COUPLET, EARLY VPC, BIGEMINY, FREQ VPC, TACHYCARDIA, BRADYCARDIA
Arrhythmia recall:	
Number of recall files:	16
Storage time per file:	8 s
ST level measurement:	
Number of measurement channels:	1 ch
Measuring range:	±2.5 mV
Alarm limits:	±2.0 mV in 0.01 mV steps, OFF
Pacemaker pulse rejection capability:	0.1 to 2 ms, ±2 to 700 mV ANSI/AAMI EC 13-1992 compatible Pacing pulse detection ON/OFF
Defibrillation-proof:	ECG input protected against 400 J IEC 60601-2-27 17.101 compatible
ESU interference filter:	Provided
Filters	ON: Time constant 0.5 s, AC hum filter 0.3 to 23 Hz (> −3 dB), ≤ −16 dB (50 Hz or 60 Hz) OFF: Time constant 3.2 s, 0.05 to 150 Hz (> −3 dB)
Lead:	
3-electrode cable:	I, II, III
6-electrode cable:	I, II, III, aVR, aVL, aVF, V4, V5
Waveform display:	
Display sensitivity:	10 mm/mV ±5% (at ×1 sensitivity)
Sensitivity control:	×1/4, ×1/2, ×1, ×2, ×4, or AUTO
Pacing spike display:	Available
Heart rate display update cycle:	Every 3 s or when alarm is generated
Alarm items:	
Upper limit range:	20 to 300 beats/min in 5 beats/min steps, OFF
Lower limit range:	OFF, 15 to 295 beats/min in 5 beats/min steps
Alarm items:	TACHYCARDIA, BRADYCARDIA, ASYSTOLE

Respiration (Transthoracic impedance pneumography)

Measuring lead:	R-F or R-L
Measuring impedance available range:	0 to 2 kΩ
Internal noise:	≤0.2 Ω (Refer to input)
Excitor current:	30 ±10 μArms at 40 kHz
Frequency response:	3.0 Hz ±1 Hz (−3 dB) (Hardware specification)
Time constant:	1.5 s ±0.5 s (Hardware specification)
Respiration counter counting range:	0 to 150 breaths/min
Respiration rate counting accuracy:	±2 breaths/min
Defibrillation proof:	Respiration input protected against 400 J discharge
Waveform display:	
Display sensitivity:	10 mm/Ω ±20% (at ×1 sensitivity, Zo=480 Ω)
Sensitivity control:	×1/4, ×1/2, ×1, ×2, ×4

Measurement On/Off:	Available
Respiration rate display update cycle:	Every 3 s or when alarm is generated
Alarm:	
Upper limit range:	2 to 150 breaths/min in 2 breaths/min steps, OFF
Lower limit range:	OFF, 0 to 148 breaths/min in 2 steps
Apnea time:	OFF, 5 to 40 s in 5 s steps

SpO_2 on BSM-2301A/C/K, BSM-2303C/K, BSM-2351A/C/K and BSM-2353C/K

Measuring range:	1 to 100%
Pulse rate counting range:	0, 30 to 300 beats/min
SpO_2 accuracy:	±2 digits (80% ≤ SpO_2 ≤ 100%)
	±3 digits (70% ≤ SpO_2 < 80%)
SpO_2 display:	
Pulse rate display update cycle:	Every 3 s or when alarm is generated
Sync tone modulation:	Change in 20 steps at 81 to 100% SpO_2
Waveform sensitivity:	×1/8, ×1/4, ×1/2, ×1, ×2, ×4, ×8 or AUTO
Alarm:	
Upper limit range:	51 to 100% SpO_2 in 1% SpO_2 steps, OFF
Lower limit range:	OFF, 50 to 99% SpO_2 in 1% SpO_2 steps

SpO_2 on BSM-2304A

Measuring range:	1 to 100%
Pulse rate counting range:	0, 20 to 250 beats/min
SpO_2 accuracy:	Adult: ±2 digits (70% ≤ SpO_2 ≤ 100%)
	Neonate: ±3 digits (70% ≤ SpO_2 < 100%)
SpO_2 display:	
Pulse rate display update cycle:	Every 3 s or when alarm is generated
Sync tone modulation:	Change in 20 steps at 81 to 100% SpO_2
Waveform sensitivity:	×1/8, ×1/4, ×1/2, ×1, ×2, ×4, ×8 or AUTO
Alarm:	
Upper limit range:	51 to 100% SpO_2 in 1% SpO_2 steps, OFF
Lower limit range:	OFF, 50 to 99% SpO_2 in 1% SpO_2 steps

Non Invasive Blood pressure, NIBP

Measuring method:	Oscillometric
Measuring range:	0 to 300 mmHg
Accuracy:	±3 mmHg (0 mmHg ≤ NIBP ≤ 200 mmHg)
	±4 mmHg (200 mmHg ≤ NIBP ≤ 300 mmHg)
Cuff inflation time:	Adult: 7 s
	Neonate: 5 s
Initial cuff inflation pressure:	Adult: 180 mmHg
	Neonate: 100 mmHg
Safety:	
Cuff inflation maximum pressure:	Adult 300 mmHg
	Neonate 150 mmHg
Safety cuff inflation limiter:	Adult 330 mmHg
	Neonate 165 mmHg
Cuff inflation time limiter:	Adult ≤180 s
	Neonates ≤90 s

Measurement mode:	Manual STAT (Continuous) Periodic: 2, 2.5, 5, 10, 15, 30 min, 1, 2, 4, 8 hr interval, PWTT (PWTT is not available on the BSM-2304A monitor)
NIBP data display update cycle:	Updated every measurement
Measurement completion sound:	Generated at every measurement completion when set on the SYSTEM SETUP screen
Alarm:	
Upper limit range:	15 to 260 mmHg in 5 mmHg steps, OFF
Lower limit range:	OFF, 10 to 255 mmHg in 5 mmHg steps

Temperature

Measuring range:	0 to 45°C
Measuring accuracy:	±0.1°C (25°C ≤ Temp ≤ 45°C) ±0.2°C (0°C ≤ Temp < 25°C)
Temperature drift:	within ±0.005°C /°C
Temperature range:	
Display range:	0°C to 45°C (32 to 113°F)
Display update cycle:	Every 3 s or when alarm is generated
Alarm:	
Upper limit range:	0.1 to 45°C (32 to 113°F) in 0.1°C (1°F) steps, OFF
Lower limit range:	OFF, 0 to 44.9°C (31 to 112°F) in 0.1°C (1°F) steps

Multi-parameter Amplifier

Measuring parameters:	IBP, respiration (thermistor method), and CO_2 (mainstream)
Input impedance:	1 MΩ ±10%
Excitor output impedance:	< 2 Ω
Excitor current limiter:	< 100 mA
Maximum current from +5 V DC connector:	< 100 mA

Invasive Blood Pressure, IBP

Measuring range:	–50 to 300 mmHg
Measuring accuracy:	±1 mmHg ±1 digit (–50 mmHg ≤ IBP < 100 mmHg) ±1% ±1 digit (100 mmHg ≤ IBP ≤ 300 mmHg)
Auto zero balancing range:	±200 mmHg
Auto zero balancing accuracy:	±1 mmHg
Transducer sensitivity:	50 µV/V/10 mmHg
Pulse rate counting range:	0, 12 to 300 beats/min
Pulse rate counting accuracy:	±2 beats/min
Noise:	Within ±1 mmHg
Temperature zero drift:	±0.1 mmHg/°C
Frequency response:	DC to 20 Hz ±3Hz DC to 12 Hz ±3Hz
Display update cycle:	Every 3 s or when alarm is generated
BP sync sound:	Provided, systolic value 20 to 120 mmHg, changes in 20 steps every 5 mmHg
Alarm:	
Upper limit range:	2 to 300 mmHg in 2 mmHg steps, OFF
Lower limit range:	OFF, 0 to 298 mmHg steps in 2 mmHg steps

Respiration (Thermistor method)

Respiration rate counting range:	0 to 150 breaths/min
	Apnea, 5 to 40 s
Accuracy:	±2 breaths/min
Noise:	Within 20 Ω (Refer to input)
Frequency response:	3.0 Hz (–3 dB)
Time constant:	≥1.5 s
Waveform display	
Display sensitivity:	10 mm/100 Ω ±20% (at ×1 sensitivity)
Sensitivity control:	×1/4, ×1/2, ×1, ×2, ×4
Respiration rate display update cycle:	Every 3 s or when alarm is generated
Alarm:	
Upper limit range:	2 to 150 breaths/min in 2 breaths/min steps, OFF
Lower limit range:	OFF, 0 to 148 breaths/min in 2 breaths/min
Apnea time:	OFF, 5 to 40 s in 5 s steps

Expired Carbon Dioxide Tension, CO_2

For the TG-900P/TG-920P/TG-950P CO_2 sensor kit specifications, refer to the kit manual.

Measuring method:	Mainstream (TG-900P/TG-920P: semi-quantitative, TG-950P: quantitative)
Measuring range:	
TG-900P/TG-920P:	0 to 76 mmHg
TG-950P:	0 to 99 mmHg
Warm-up time:	5 s (minimum)
Response time	
TG-900P:	200 ms (typical) for steps from 10 to 90%
TG-920P:	120 ms (typical) for steps from 10 to 90%
TG-950P:	60 ms (typical) for steps from 10 to 90%, delay time 100 ms ±10 ms
Detectable respiration rate	
TG-900P:	3 to 60 breaths/min
TG-920P:	3 to 150 breaths/min
TG-950P:	0 to 150 breaths/min
Respiration rate counting accuracy:	±2 breaths/min
Measuring accuracy:	
TG-900P/TG-920P:	±4 mmHg ($0 \leq CO_2 \leq 40$ mmHg)
	±10% reading ($40 < CO_2 \leq 76$ mmHg)
	(When 1 atmospheric pressure, $N_2O \leq 70$ %, no condensation)
TG-950P:	±2 mmHg ($0 \leq CO_2 \leq 40$ mmHg)
	±5% reading ($40 < CO_2 \leq 70$ mmHg)
	±7% reading ($70 < CO_2 \leq 100$ mmHg)
	(When no condensation, $N_2O \leq 70$ %)
CO_2 value display update cycle:	Every 3 s or when alarm is generated
Alarm:	
Upper limit range:	2 to 99 mmHg in 1 mmHg in 1 steps, OFF
Lower limit range:	OFF, 1 to 98 mmHg in 1 steps
Apnea time:	OFF, 5 to 40 s

Trendgraph

Trend parameters:	Heart rate (or pulse rate), respiration rate, VPC rate, ST level, EVENT (arrhythmia), apnea (time), apnea (frequency), SpO_2, NIBP (systolic, diastolic and mean), IBP (systolic, diastolic and mean), temperature, $ETCO_2$ and PWTT

Trend times:	1, 2, 4, 8, and 24 h
Data sampling time:	1 min for 1, 2, 4, 8 hours, 3 min for 24 hours

Vital Signs List

Parameters:	Heart rate (or pulse rate), VPC rate, ST level, NIBP (systolic, diastolic and mean), SpO_2, IBP (systolic, diastolic and mean), respiration rate, temperature and $ETCO_2$
Number of files in list:	Periodic vital signs list: 120
	Entries in vital signs list at NIBP measurement: 120
List interval:	Periodic vital signs list: 1, 5, 15, 30 or 60 minutes
	Vital signs list at NIBP measurement: at NIBP measurement

Recorder Module (optional, WS-231P)

Recording method:	Thermal array recording
Number of channels:	3 traces (maximum)
Recording width:	≥46 mm
Paper speed:	25, 50 mm/s
Recording paper:	FQW50-3-100
Resolution:	Amplitude direction of waveforms: 8 dots/mm
	Time direction of waveforms: 40 lines/mm
	8 lines/mm (graphic recording)
Dimensions:	212 W × 90 H × 140 D (mm)
Weight:	1.5 kg

Interface (optional, QI-231P)

ECG analog output

Output voltage:	within ±5 V
Sensitivity:	1 V/1 mV ±5%
Frequency:	low 0.6 Hz ±0.1 Hz (–3 dB)
	high 23 Hz ±3 Hz (–3 dB)
Delay time:	within 20 ms

Trigger output

Output format:	open collector
External application signal:	voltage +5 to +15 V
	current 500 µA to 100 mA
QRS sync delay time:	within 100 ms

Interface (optional, QI-236P)

ECG analog output

Output voltage:	within ±5 V
Sensitivity:	1 V/1 mV ±5%
Frequency:	low 0.6 Hz ±0.1 Hz (–3 dB)
	high 23 Hz ±3 Hz (–3 dB)
Delay time:	within 20 ms

Trigger output

Output format:	TTL compatible
QRS sync delay time:	within 20 ms

External Output

ZB-900PK:	Provided
External monitor:	Provided

Power Requirement

Line voltage:	BSM-2301A/2304A/2351A:	117 V ±10% AC	
	BSM-2301C/K, BSM-2303C/K		
	BSM-2351C/K, BSM-2353C/K:	100 to 240 V ±10% AC	
Line frequency:	50 or 60 Hz ±2%		
Battery pack (option):	10.8 to 15.0 V ±5%		
Power consumption:	AC operation:	BSM-2301A/2304A:	70 VA maximum
		BSM-2301C/K, BSM-2303C/K:	86 VA maximum
		BSM-2351A:	80 VA maximum
		BSM-2351C/K, BSM-2353C/K:	95 VA maximum
	Battery operation:	40 W maximum	

Clock Accuracy

At operating temperature 25°C:	about ±2 min 40 s/month maximum
At storage temperature –20 to 60°C:	about ±5 min/month maximum

Environment

Operating environment		
Temperature:	10 to 40°C	
Humidity:	30 to 90% RH (0 to 40°C, non-condensing)	
Atmospheric pressure:	70 to 106 kPa	
Storage environment		
Temperature:	–20 to +60°C	
	–15 to +55°C (Recording paper)	
Humidity:	10 to 90% RH (0 to 40°C, non-condensing)	
Atmospheric pressure:	70 to 106 kPa	

Dimensions and Weight

Dimensions:	BSM-2301/2303/2304:	253 W × 242 H ×145 D (mm)
	BSM-2351/2353:	293 W × 272 H × 149 D (mm)
Weight:	BSM-2301/2303/2304:	approx. 4.7 kg
	BSM-2351/2353:	approx. 5 kg

Electromagnetic Compatibility

IEC 60601-1-2:1993 – Collateral Standard: Electromagnetic compatibility – Requirement and tests

Emissions:	CISPR11 Group 1, Class B

Safety Standard

Safety standard: IEC 60601-1:1988 Amendment 1:1991, Amendment 2:1995
IEC 60601-1-1 Amendment 1:1995
IEC 60601-2-27:1994 - Particular requirements for the safety of electrocardiographic monitoring
IEC 60601-2-34:1994 - Particular requirements for the safety of direct blood pressure monitoring equipment
IEC 60601-2-30:1995 - Particular requirements for the safety of automatic cycling in in-direct blood pressure monitoring equipment

According to the type of protection against electrical shock:
CLASS I EQUIPMENT (AC Powered)
Internally Powered EQUIPMENT (BATTERY Powered)

According to the degree of protection against electrical shock

ECG, Respiration (impedance), Respiration (thermistor), IBP, Temperature, CO_2:
Defibrillator-proof type CF applied part

SpO_2, NIBP: Defibrillator-proof type BF applied part

For BSM-2301, depending on the serial number, the degree of protection against electrical shock for the specified parameters may be as follows.

Temperature: CF applied part SpO_2, Respiration (thermistor), CO_2: BF applied part

According to the degree of protection against harmful ingress of water:
IPX0 (ordinary EQUIPMENT)

According to the degree of safety of application in the presence of FLAMMABLE ANAESTHETIC MIXTURE WITH AIR, OR WITH OXYGEN OR NITROUS OXIDE:
Equipment not suitable for use in the presence of FLAMMABLE ANAESTHETIC MIXTURE WITH AIR, OR WITH OXYGEN OR NITROUS OXIDE

According to the mode of operation: CONTINUOUS OPERATION

<BSM-2354A>

Display

Display size:	10.4 inch, TFT type color LCD
Waveform display mode:	Non-fade moving or non-fade fixed
Viewing area:	211.2 mm × 158.4 mm
Resolution:	800 × 600 dots
Maximum number of waveform trace:	6 traces
Sweep speed:	25 mm/s, 50 mm/s (Respiration and CO_2 low speed: 1.56 mm/s, 6.25 mm/s)
Sweep width:	about 154 mm at 25 mm/s sweep speed
Waveform display color:	12
Numeric display color:	12
Waveform freeze:	Provided
Display waveforms:	ECG, respiration, IBP, SpO_2 pulse wave and CO_2
Numerical data display:	Heart rate, VPC rate, ST level, respiration rate, IBP (systolic, diastolic, mean), NIBP (systolic, diastolic, mean), SpO_2, pulse rate, temperature, $EtCO_2$ and $FiCO_2$
Synchronization mark:	Heart rate sync mark, pulse rate sync mark, respiratory sync mark

Sound

Sound type:	Alarm, synchronization, click
Alarm sound:	3 types
Synchronization sound:	Pitch variable for IBP and SpO_2

Alarm

Alarm items:	Upper/lower limits alarm, apnea alarm, arrhythmia alarm, connector disconnection alarm, noise alarm, electrode off alarm, pulse waveform detecting alarm, probe off alarm, cuff/hose check alarm, sensor check alarm, battery weak alarm, operating environment alarm
Alarm levels:	Crisis (red blinking), Warning (yellow blinking), Advisory (yellow lighting)
Alarm indication:	Alarm indicator, highlighted message, alarm sound
Alarm suspend:	Provided
Alarm signal delay in CNS network	≤4 s

ECG

Electrode offset potential tolerance:	±500 mV
Input dynamic range:	± 5 mV
Internal noise:	≤30 μVp-p (Refer to input)
Common mode rejection ratio:	≥95 dB
Input impedance	≥5 MΩ (at 10 Hz)
Input bias current:	≤100 nA
Heart rate count	
Calculation method:	Moving average/Instantaneous beat to beat (selectable)
Counting range:	0, 12 to 300 beats/min (±2 beats/min)
Arrhythmia analysis	
Analysis method:	Template matching method
Number of channels:	1 channel
VPC counting rate:	0 to 99 VPCs/min
Arrhythmia message:	ASYSTOLE, VT, VF, VPC RUN, COUPLET, EARLY VPC, BIGEMINY, FREQ VPC, TACHYCARDIA, BRADYCARDIA

Arrhythmia recall:	
Number of recall files:	16
Storage time per file:	8 s
ST level measurement:	
Number of measurement channels:	1 ch
Measuring range:	±2.5 mV
Alarm limits:	±2.0 mV in 0.01 mV steps, OFF
Pacemaker pulse rejection capability:	0.1 to 2 ms, ±2 to 700 mV
	ANSI/AAMI EC 13-1992 compatible
	Pacing pulse detection ON/OFF
Defibrillation-proof:	ECG input protected against 400 J
	IEC 60601-2-27 17.101 compatible
ESU interference filter:	Provided
Filters	ON: Time constant 0.5 s, AC hum filter 0.3 to 23 Hz (> –3 dB), ≤ –16 dB (50 Hz or 60 Hz)
	OFF: Time constant 3.2 s, 0.05 to 150 Hz (> –3 dB)
Lead:	
3-electrode cable:	I, II, III
6-electrode cable:	I, II, III, aVR, aVL, aVF, V4, V5
Waveform display:	
Display sensitivity:	10 mm/mV ±5% (at ×1 sensitivity)
Sensitivity control:	×1/4, ×1/2, ×1, ×2, ×4, or AUTO
Pacing spike display:	Available
Heart rate display update cycle:	Every 3 s or when alarm is generated
Alarm items:	
Upper limit range:	20 to 300 beats/min in 5 beats/min steps, OFF
Lower limit range:	OFF, 15 to 295 beats/min in 5 beats/min steps
Alarm items:	TACHYCARDIA, BRADYCARDIA, ASYSTOLE

Respiration (Transthoracic impedance pneumography)

Measuring lead:	R-F or R-L
Measuring impedance available range:	0 to 2 kΩ
Internal noise:	≤0.2 Ω (Refer to input)
Excitor current:	30 ±10 μArms at 40 kHz
Frequency response:	3.0 Hz ±1 Hz (–3 dB) (Hardware specification)
Time constant:	1.5 s ±0.5 s (Hardware specification)
Respiration counter counting range:	0 to 150 breaths/min
Respiration rate counting accuracy:	±2 breaths/min
Defibrillation proof:	Respiration input protected against 400 J discharge
Waveform display:	
Display sensitivity:	10 mm/Ω ±20% (at ×1 sensitivity, Zo=480 Ω)
Sensitivity control:	×1/4, ×1/2, ×1, ×2, ×4
Measurement On/Off:	Available
Respiration rate display update cycle:	Every 3 s or when alarm is generated
Alarm:	
Upper limit range:	2 to 150 breaths/min in 2 breaths/min steps, OFF
Lower limit range:	OFF, 0 to 148 breaths/min in 2 steps
Apnea time:	OFF, 5 to 40 s in 5 s steps

SpO_2

Measuring range:	1 to 100%
Pulse rate counting range:	0, 20 to 250 beats/min
SpO_2 accuracy:	Adult: ±2 digits (70% ≤ SpO_2 ≤100%)
	Neonate: ±3 digits (70% ≤ SpO_2 ≤100%)
SpO_2 display:	
Pulse rate display update cycle:	Every 3 s or when alarm is generated
Sync tone modulation:	Change in 20 steps at 81 to 100% SpO_2
Waveform sensitivity:	×1/8, ×1/4, ×1/2, ×1, ×2, ×4, ×8 or AUTO
Alarm:	
Upper limit range:	51 to 100% SpO_2 in 1% SpO_2 steps, OFF
Lower limit range:	OFF, 50 to 99% SpO_2 in 1% SpO_2 steps

Non Invasive Blood pressure, NIBP

Measuring method:	Oscillometric
Measuring range:	0 to 300 mmHg
Accuracy:	±3 mmHg (0 mmHg ≤ NIBP ≤ 200 mmHg)
	±4 mmHg (200 mmHg ≤ NIBP ≤ 300 mmHg)
Cuff inflation time:	Adult: 7 s
	Neonate: 5 s
Initial cuff inflation pressure:	Adult: 180 mmHg
	Neonate: 100 mmHg
Safety:	
Cuff inflation maximum pressure:	Adult 300 mmHg
	Neonate 150 mmHg
Safety cuff inflation limiter:	Adult 330 mmHg
	Neonate 165 mmHg
Cuff inflation time limiter:	Adult ≤180 s
	Neonates ≤90 s
Measurement mode:	Manual
	STAT (Continuous)
	Periodic: 2, 2.5, 5, 10, 15, 30 min, 1, 2, 4, 8 hr interval
NIBP data display update cycle:	Updated every measurement
Measurement completion sound:	Generated at every measurement completion when set on the SYSTEM SETUP screen
Alarm:	
Upper limit range:	15 to 260 mmHg in 5 mmHg steps, OFF
Lower limit range:	OFF, 10 to 255 mmHg in 5 mmHg steps

Temperature

Measuring range:	0 to 45°C
Measuring accuracy:	±0.1°C (25°C ≤ Temp ≤ 45°C)
	±0.2°C (0°C ≤ Temp < 25°C)
Temperature drift:	within ±0.005°C /°C
Temperature range:	
Display range:	0°C to 45°C (32 to 113°F)
Display update cycle:	Every 3 s
Alarm:	
Upper limit range:	0.1 to 45°C (32 to 113°F) in 0.1°C (1°F) steps, OFF
Lower limit range:	OFF, 0 to 44.9°C (31 to 112°F) in 0.1°C (1°F) steps

Multi-parameter Amplifier

Measuring parameters:	IBP, respiration (thermistor method), and CO_2 (mainstream)
Input impedance:	1 MΩ ±10%
Excitor output impedance:	< 2 Ω
Excitor current limiter:	< 100 mA
Maximum current from +5 V DC connector:	< 100 mA

Invasive Blood Pressure, IBP

Measuring range:	–50 to 300 mmHg
Measuring accuracy:	±1 mmHg ±1 digit (–50 mmHg ≤ IBP < 100 mmHg)
	±1% ±1 digit (100 mmHg ≤ IBP ≤ 300 mmHg)
Auto zero balancing range:	±200 mmHg
Auto zero balancing accuracy:	±1 mmHg
Transducer sensitivity:	50 µV/V/10 mmHg
Pulse rate counting range:	0, 12 to 300 beats/min
Pulse rate counting accuracy:	±2 beats/min
Noise:	Within ±1 mmHg
Temperature zero drift:	±0.1 mmHg/°C
Frequency response:	DC to 20 Hz ±3Hz
	DC to 12 Hz ±3Hz
Display update cycle:	Every 3 s or when alarm is generated
BP sync sound:	Provided, systolic value 20 to 120 mmHg, changes in 20 steps every 5 mmHg
Alarm:	
Upper limit range:	2 to 300 mmHg in 2 mmHg steps, OFF
Lower limit range:	OFF, 0 to 298 mmHg steps in 2 mmHg steps

Respiration (Thermistor method)

Respiration rate counting range:	0 to 150 breaths/min
	Apnea, 5 to 40 s
Accuracy:	±2 breaths/min
Noise:	Within 20 Ω (Refer to input)
Frequency response:	3.0 Hz (–3 dB)
Time constant:	≥1.5 s
Waveform display	
Display sensitivity:	10 mm/100 Ω ±20% (at ×1 sensitivity)
Sensitivity control:	×1/4, ×1/2, ×1, ×2, ×4
Respiration rate display update cycle:	Every 3 s or when alarm is generated
Alarm:	
Upper limit range:	2 to 150 breaths/min in 2 breaths/min steps, OFF
Lower limit range:	OFF, 0 to 148 breaths/min in 2 breaths/min
Apnea time:	OFF, 5 to 40 s in 5 s steps

Expired Carbon Dioxide Tension, CO_2

For the TG-900P/TG-920P/TG-950P CO_2 sensor kit specifications, refer to the kit manual.

Measuring method:	Mainstream (TG-900P/TG-920P: semi-quantitative, TG-950P: quantitative)
Measuring range:	
TG-900P/TG-920P:	0 to 76 mmHg
TG-950P:	0 to 99 mmHg
Warm-up time:	5 s (minimum)

Response time
- TG-900P: 200 ms (typical) for steps from 10 to 90%
- TG-920P: 120 ms (typical) for steps from 10 to 90%
- TG-950P: 60 ms (typical) for steps from 10 to 90%, delay time 100 ms ±10 ms

Detectable respiration rate
- TG-900P: 3 to 600 breaths/min
- TG-920P: 3 to 150 breaths/min
- TG-950P: 0 to 150 breaths/min

Respiration rate counting accuracy: ±2 breaths/min

Measuring accuracy:
- TG-900P/TG-920P: ±4 mmHg ($0 \leq CO_2 \leq 40$ mmHg)
  ±10% reading ($40 < CO_2 \leq 76$ mmHg)
  (When 1 atmospheric pressure, $N_2O \leq 70$ %, no condensation)
- TG-950P: ±2 mmHg ($0 \leq CO_2 \leq 40$ mmHg)
  ±5% reading ($40 < CO_2 \leq 70$ mmHg)
  ±7% reading ($70 < CO_2 \leq 100$ mmHg)
  (When no condensation, $N_2O \leq 70$ %)

CO_2 value display update cycle: Every 3 s or when alarm is generated

Alarm:
- Upper limit range: 2 to 99 mmHg in 1 mmHg in 1 steps, OFF
- Lower limit range: OFF, 1 to 98 mmHg in 1 steps
- Apnea time: OFF, 5 to 40 s

Trendgraph

Trend parameters: Heart rate (or pulse rate), respiration rate, VPC rate, ST level, EVENT (arrhythmia), apnea (time), apnea (frequency), SpO_2, NIBP (systolic, diastolic and mean), IBP (systolic, diastolic and mean), temperature and $EtCO_2$

Trend times: 1, 2, 4, 8, and 24 h

Data sampling time: 1 min for 1, 2, 4, 8 hours, 3 min for 24 hours

Vital Signs List

Parameters: Heart rate (or pulse rate), VPC rate, ST level, NIBP (systolic, diastolic and mean), SpO_2, IBP (systolic, diastolic and mean), respiration rate, temperature and $EtCO_2$

Number of files in list:
- Periodic vital signs list: 120
- Entries in vital signs list at NIBP measurement: 120

List interval:
- Periodic vital signs list: 1, 5, 15, 30 or 60 minutes
- Vital signs list at NIBP measurement: at NIBP measurement

Recorder Module (optional, WS-231P)

Recording method: Thermal array recording

Number of channels: 3 traces (maximum)

Recording width: ≥46 mm

Paper speed: 25, 50 mm/s

Recording paper: FQW50-3-100

Resolution:
- Amplitude direction of waveforms: 8 dots/mm
- Time direction of waveforms: 40 lines/mm
  8 lines/mm (graphic recording)

Dimensions: 212 mm W × 90 mm H × 140 mm D

Weight: 1.5 kg

External Output

External monitor: Provided

Power Requirement

Line voltage: 117 V ± 10% AC
Line frequency: 50 or 60 Hz ±2%
Battery pack (option): 10.8 to 15.0 V ±5%
Power consumption: AC operation: 80 VA maximum
Battery operation: 40 W maximum

Clock Accuracy

At operating temperature 25°C: about ±2 min 40 s/month (maximum)
At storage temperature –20 to 60°C: about ±5 min/month (maximum)

Environment

Operating environment
- Temperature: 10 to 40°C
- Humidity: 30 to 90% RH (0 to 40°C, non-condensing)
- Atmospheric pressure: 70 to 106 kPa

Storage environment
- Temperature: –20 to +60°C
  –15 to +55°C (Recording paper)
- Humidity: 10 to 90% RH (0 to 40°C, non-condensing)
- Atmospheric pressure: 70 to 106 kPa

Dimensions and Weight

Dimensions: 293 W × 272 H ×149 D (mm)
Weight: approx. 5 kg

Electromagnetic Compatibility

IEC 60601-1-2: 2001

Safety Standard

Safety standard: IEC 60601-1: 1988 Amendment 1: 1991, Amendment 2: 1995
IEC 60601-1-1: 2000
IEC 60601-2-27: 1994 - Particular requirements for the safety of electrocardiographic monitoring
IEC 60601-2-34: 1994 - Particular requirements for the safety of direct blood pressure monitoring equipment
IEC 60601-2-30: 1995 - Particular requirements for the safety of automatic cycling in in-direct blood pressure monitoring equipment
IEC 60601-2-49: 2001

According to the type of protection against electrical shock:
CLASS I EQUIPMENT (AC Powered)
Internally Powered EQUIPMENT (BATTERY Powered)

According to the degree of protection against electrical shock
- ECG, Respiration (impedance), Respiration (thermistor), IBP, CO_2, Temperature: Defibrillator-proof type CF applied part
- SpO_2, NIBP: Defibrillator-proof type BF applied part

According to the degree of protection against harmful ingress of water:
IPX0 (ordinary EQUIPMENT)

According to the degree of safety of application in the presence of FLAMMABLE ANAESTHETIC MIXTURE WITH AIR OR WITH OXYGEN OR NITROUS OXIDE:
Equipment not suitable for use in the presence of FLAMMABLE ANAESTHETIC MIXTURE WITH AIR OR WITH OXYGEN OR NITROUS OXIDE

According to the mode of operation: CONTINUOUS OPERATION

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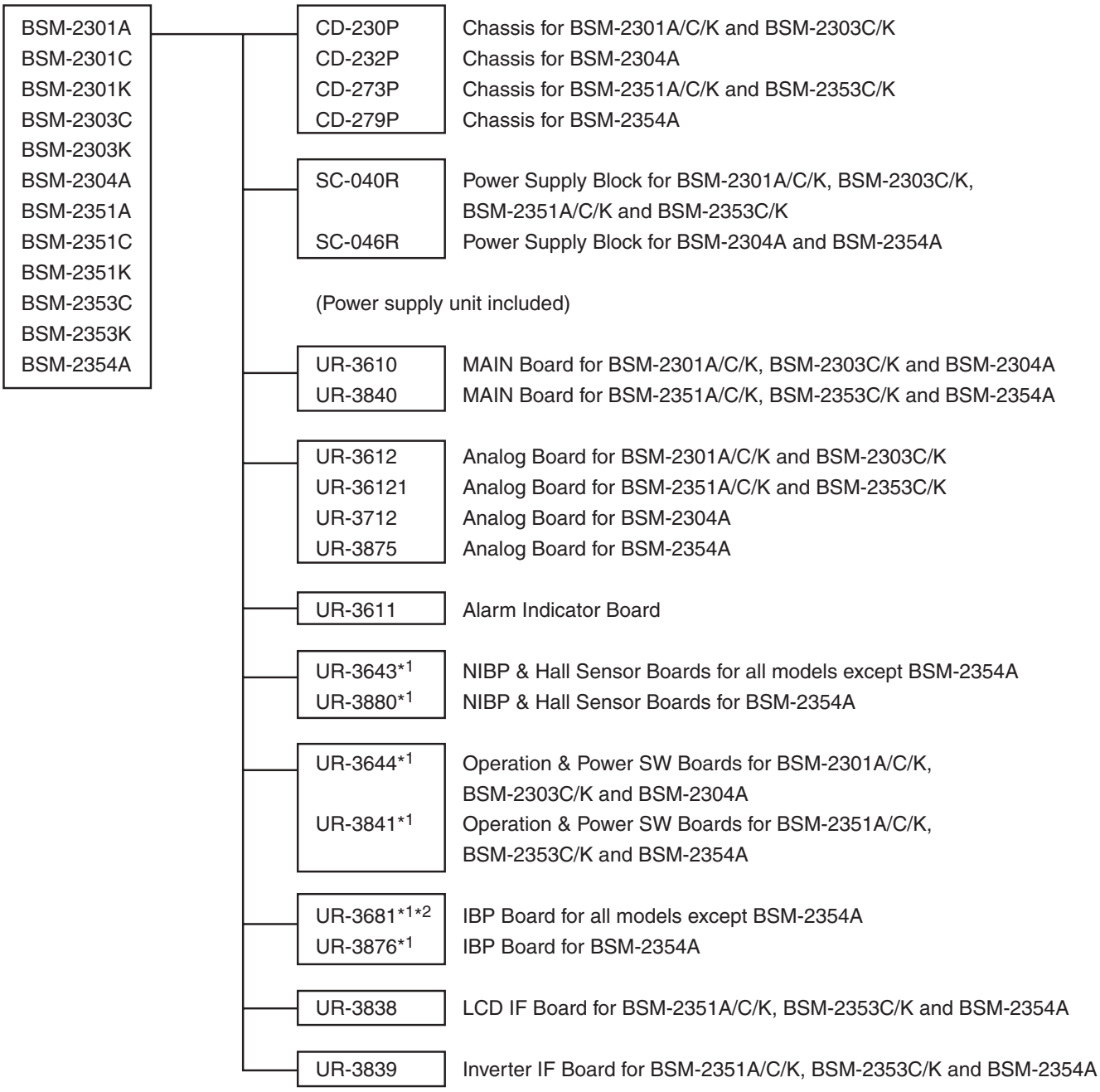
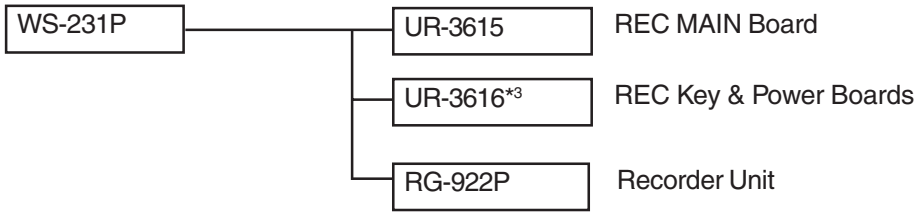
Composition



*1 Refer to “Replaceable Parts List” in Section 8.

*2 BSM-2301A/C/K and BSM-2351A/C/K have no IBP board.

Recorder Module (option)

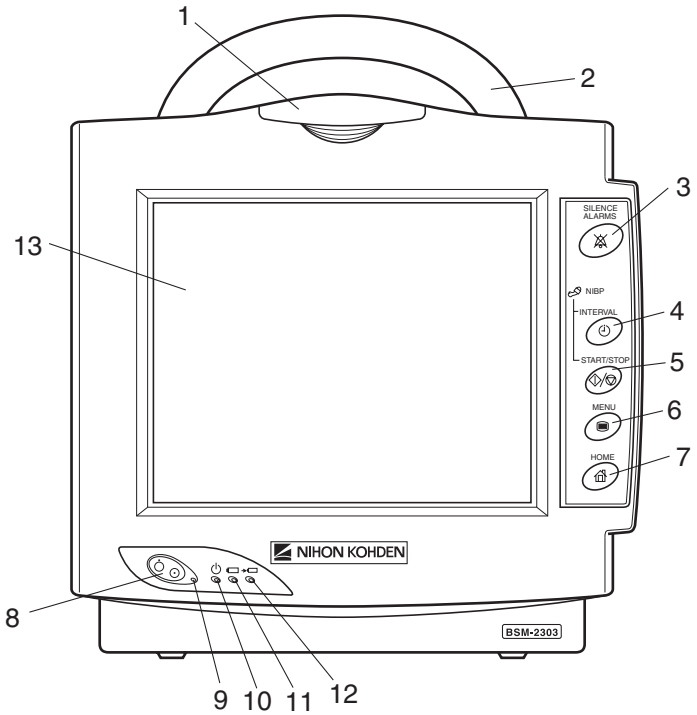


*3 Refer to “Optional Recorder Module WS-231P” in Section 8.

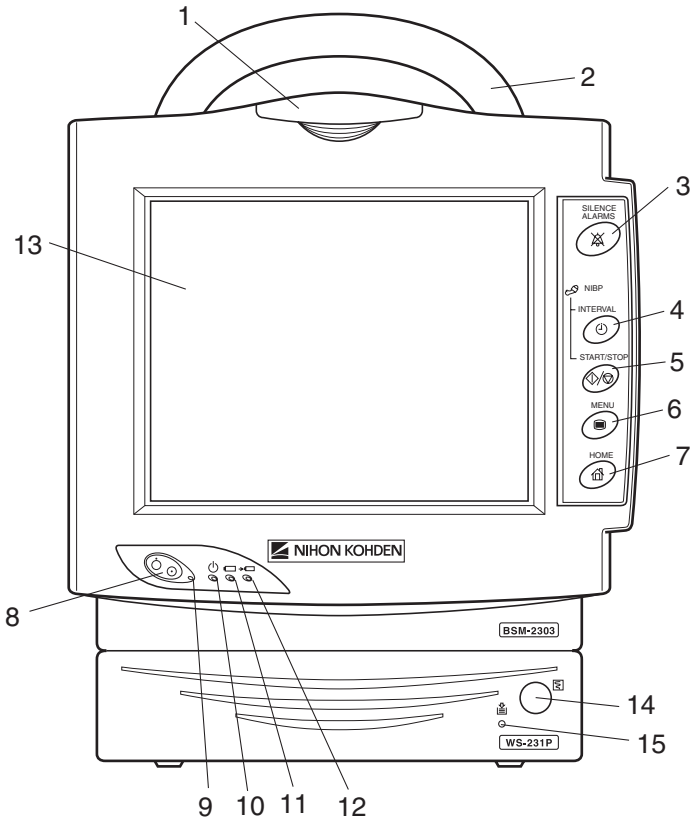
Interface (option)

Panel Descriptions

Front Panel



Without optional WS-231P recorder module

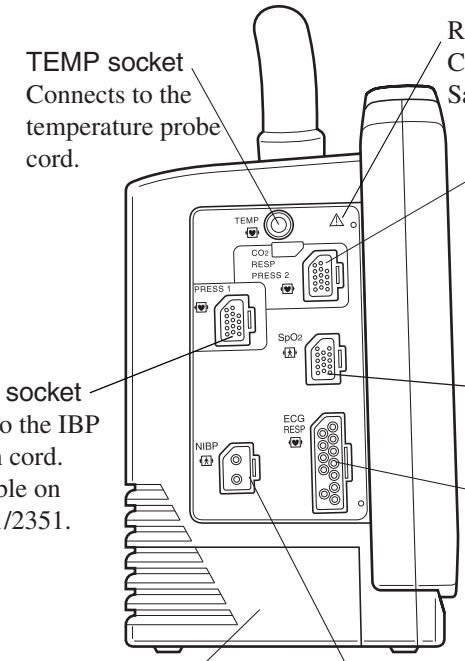


With optional WS-231P recorder module

No.	Name	Description
1	Alarm indicator	Red or orange lamp blinks according to the alarm settings. Green lamp blinks in synchronization with the patient's QRS.
2	Handle	For carrying the monitor.
3	SILENCE ALARMS key	Silences the alarm sound.
4	NIBP INTERVAL key	Selects NIBP measurement mode. Pressing this key changes the mode.
5	NIBP START/STOP key	Starts NIBP measurement in selected mode. Pressing the key during measurement stops measurement.
6	MENU key	Displays the MENU window.
7	HOME key	Closes any opened window and displays the monitoring screen.
8	Power switch	Press and hold for more than one second to turn the monitor power on or off.
9	Power lamp	Lights when the monitor power is turned on.
10	AC power lamp	Lights when the power cord is connected between the AC SOURCE socket and AC outlet.
11	Battery power lamp	Lights when operating on the battery power.
12	Battery charging lamp	Lights or slowly blinks when charging.
13	Touch screen	Displays monitoring data. Touching a key or data on the screen changes displaying screen and settings.
14	Record key	Press to start or stop recording.
15	Out of paper lamp	Blinks when out of paper. Lights when paper magazine is open.

Left Side Panel

BSM-2301A/C/K, BSM-2303C/K, BSM-2351A/C/K and BSM-2353C/K



TEMP socket
Connects to the temperature probe cord.

Refer to Warning and Caution in the "General Safety Information" section.

Multi-parameter socket
Connects to the connection cord of the parameter to be monitored (IBP (PRESS for BSM-2301/2351, PRESS 2 for BSM-2303/2353), CO_2 or respiration by thermistor method). The type of parameter is automatically recognized.

PRESS 1 socket
Connects to the IBP connection cord.
Not available on BSM-2301/2351.

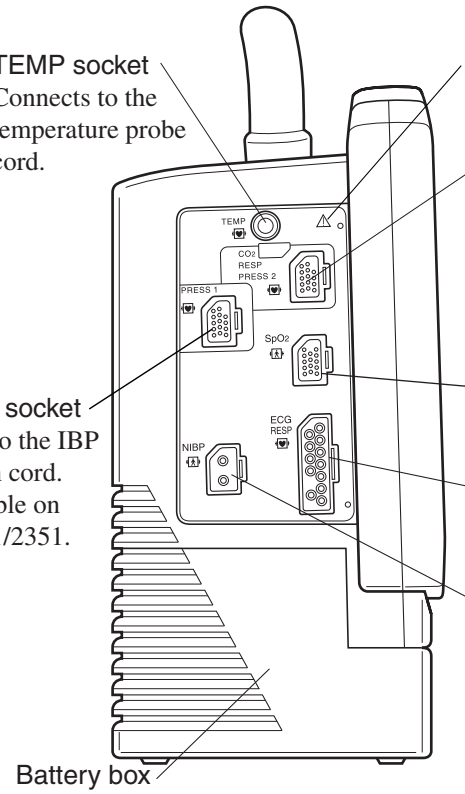
SpO_2 socket
Connects to the SpO_2 connection cord.

ECG/RESP socket
Connects to the ECG connection cord.

NIBP socket
Connects to the air hose.

Battery box
For the optional battery pack.

Without optional WS-231P recorder module



TEMP socket
Connects to the temperature probe cord.

Refer to Warning and Caution in the "General Safety Information" section.

Multi-parameter socket
Connects to the connection cord of the parameter to be monitored (IBP (PRESS for BSM-2301/2351, PRESS 2 for BSM-2303/2353), CO_2 or respiration by thermistor method). The type of parameter is automatically recognized.

PRESS 1 socket
Connects to the IBP connection cord.
Not available on BSM-2301/2351.

SpO_2 socket
Connects to the SpO_2 connection cord.

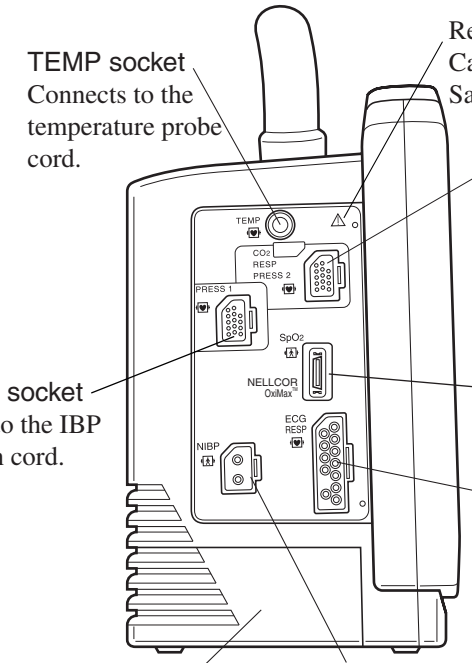
ECG/RESP socket
Connects to the ECG connection cord.

NIBP socket
Connects to the air hose.

Battery box
For the optional battery pack.

With optional WS-231P recorder module

BSM-2304A/2354A



TEMP socket
Connects to the temperature probe cord.

Refer to Warning and Caution in the "General Safety Information" section.

Multi-parameter socket
Connects to the connection cord of the parameter to be monitored (IBP (PRESS 2), CO_2 or respiration by thermistor method). The type of parameter is automatically recognized.

PRESS 1 socket
Connects to the IBP connection cord.

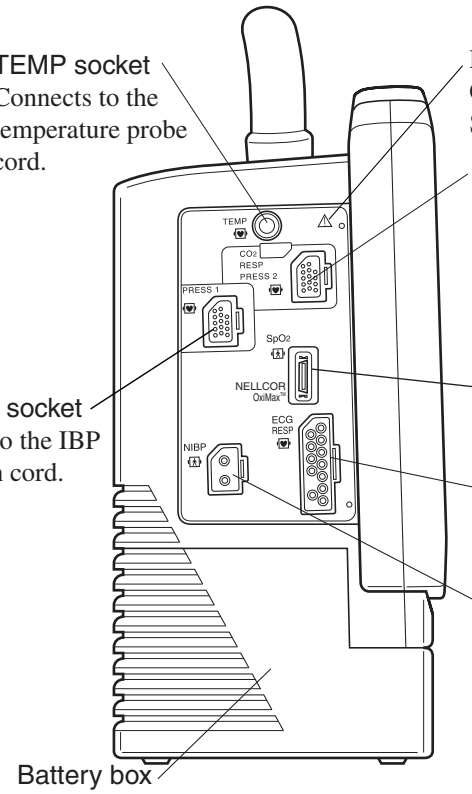
SpO_2 socket
Connects to the SpO_2 connection cord.

ECG/RESP socket
Connects to the ECG connection cord.

NIBP socket
Connects to the air hose.

Battery box
For the optional battery pack.

Without optional WS-231P recorder module



TEMP socket
Connects to the temperature probe cord.

Refer to Warning and Caution in the "General Safety Information" section.

Multi-parameter socket
Connects to the connection cord of the parameter to be monitored (IBP (PRESS 2), CO_2 or respiration by thermistor method). The type of parameter is automatically recognized.

PRESS 1 socket
Connects to the IBP connection cord.

SpO_2 socket
Connects to the SpO_2 connection cord.

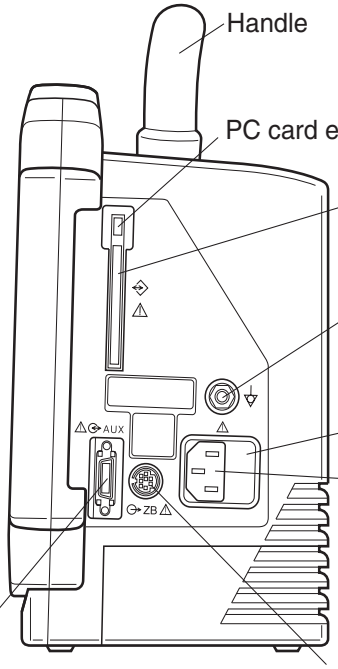
ECG/RESP socket
Connects to the ECG connection cord.

NIBP socket
Connects to the air hose.

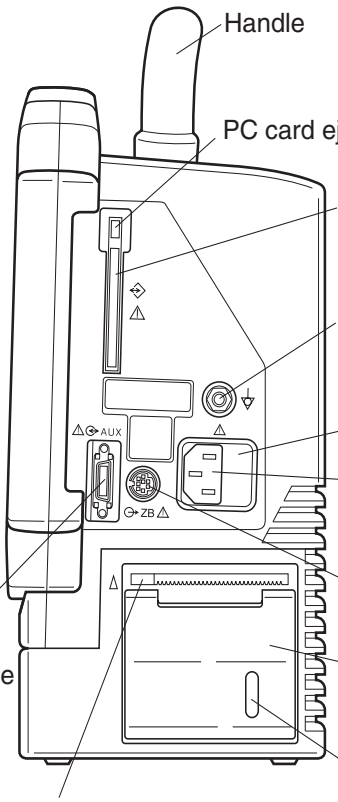
Battery box
For the optional battery pack.

With optional WS-231P recorder module

Right Side Panel



Without optional WS-231P recorder module



With optional WS-231P recorder module

Storage and Transport

Follow these procedures when storing or transporting the instrument.

Storage

Before storing the instrument for a long time, perform the following steps:

1. Disconnect the power cord from the instrument.
2. Cover the instrument with a dust cover.
3. If possible, store the instrument in its original shipping container.
4. Make sure the storage place meets the following storage conditions for the duration of the storage:

Storage temperature	–20 to 60°C (–4 to 140°F)
Storage humidity	10 to 90% RH, non-condensing

Transport

To transport the instrument, perform the following steps:

1. Disconnect the power cord from the instrument.
2. Cover the instrument with a dust cover.
3. If possible, transport the instrument in its original shipping container.

Hard Keys and Soft Keys

Hard Keys

The instrument has five hard keys: SILENCE ALARMS, NIBP interval, NIBP START/STOP, MENU and HOME.
These keys always have the same functions, regardless of the screen display.
In this manual, hard keys are indicated by CAPITAL LETTERS.

Soft Keys

When the MENU key is pressed or the screen is touched, the screen displays several keys which have different functions depending on the screen display. For example, when the HR numeric display is touched, the ECG setting screen appears and several keys such as VITAL ALARM, ARRHYTH ALARM, OTHER SETTING, etc are displayed.
In this manual, soft keys are indicated by quotation marks (for example, the “PATIENT INFO” key).

Upgrading the System Software and Changing Language on the Screen

CAUTION

Upgrading the system software and changing the language on screen erases all system and individual bed settings. Write down these settings so they can be re-entered after the software upgrade.

The instrument uses a program card for upgrading its system software and changing the screen language. When the instrument detects that a program card is inserted into its PCMCIA card slot during the booting stage after it is turned on, it checks the program card for a system program or language. If the program card contains a newer version of the system program or language, the instrument automatically replaces its current system program or language information with the new one. If the program card contains a system program whose version number is the same or older than the current one in the instrument, you have the option to replace or keep the current system program. If the program card does not contain a system program, the instrument continues the boot-up process.

In the system software upgrading or language changing process, the instrument first deletes the old system software or language stored in its system ROM. Then it checks whether the data in the system ROM is completely deleted. When the data is completely deleted, it copies the new version of the system program or language information from the program card to the system ROM and then checks the copy process. After the data is successfully copied, the self-check program starts to check the instrument.

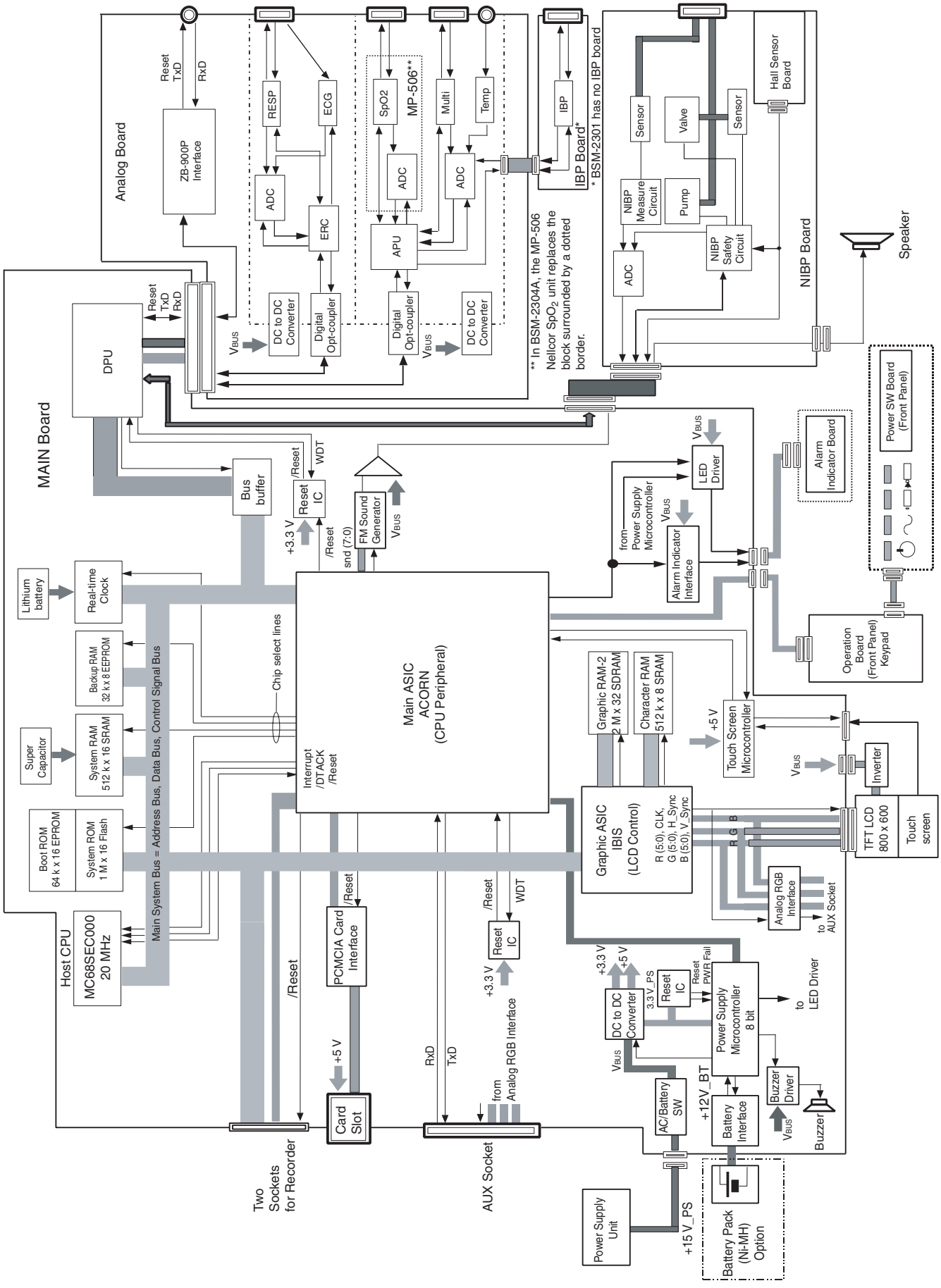
Procedure

1. Write down the System Setup settings and other monitoring settings of the instrument.
2. Insert the program card into the PCMCIA card slot on the right side panel of the instrument.
3. Turn on the instrument. The instrument performs the upgrading process and self-check programs. The DIAGNOSTIC CHECK screen appears.

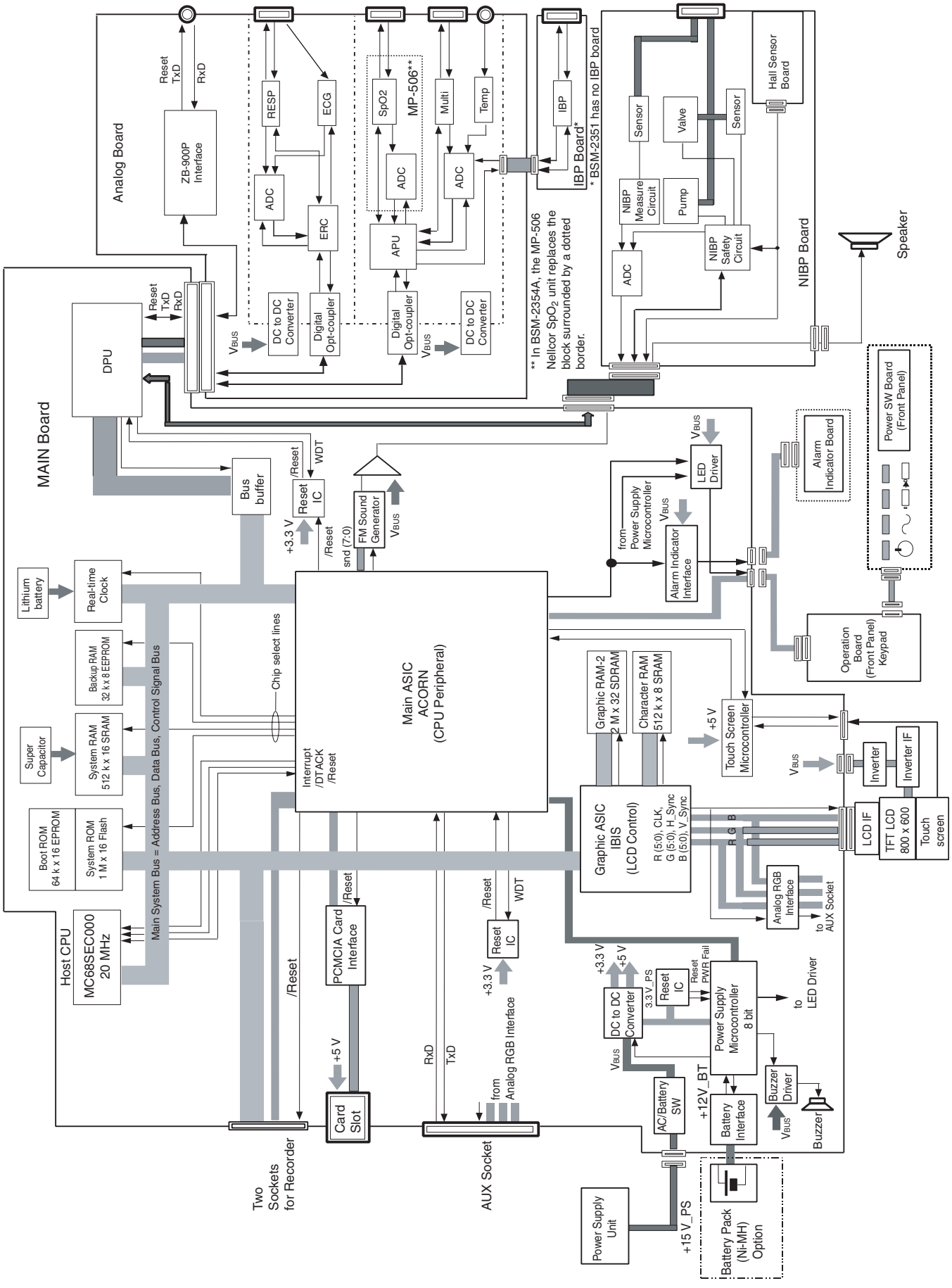
4. Touch and hold the “SYSTEM INITIALIZE” key for 2 seconds to initialize the instrument until the “PUSH 3 SECONDS” message disappears from the screen. When initializing is finished, the DIAGNOSTIC CHECK screen appears.
5. Confirm that the new system software version number appears.
6. Turn off the instrument.
7. Turn on the instrument again and check that the model number on the power on self check screen is correct.

Block Diagram

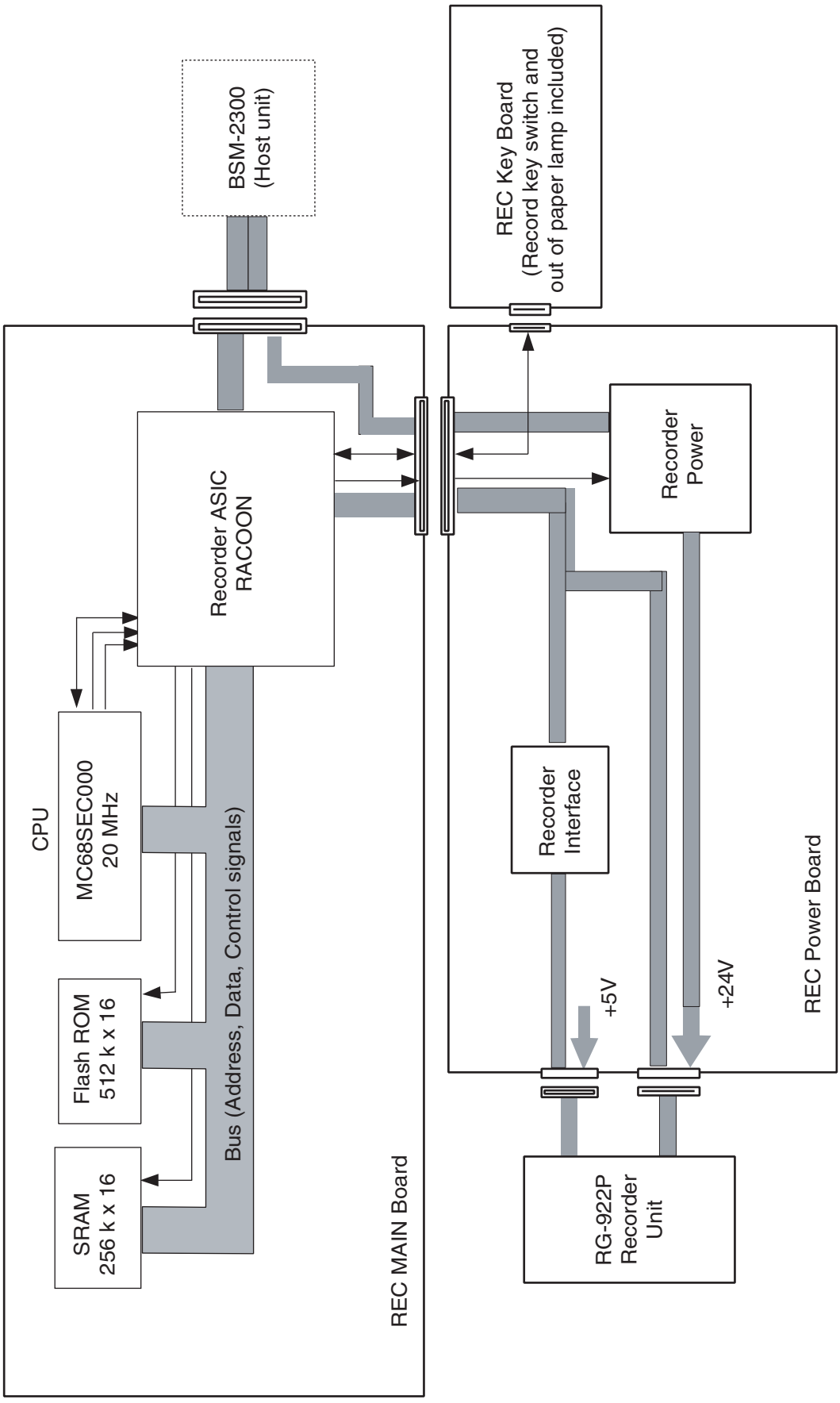
BSM-2301/2303/2304



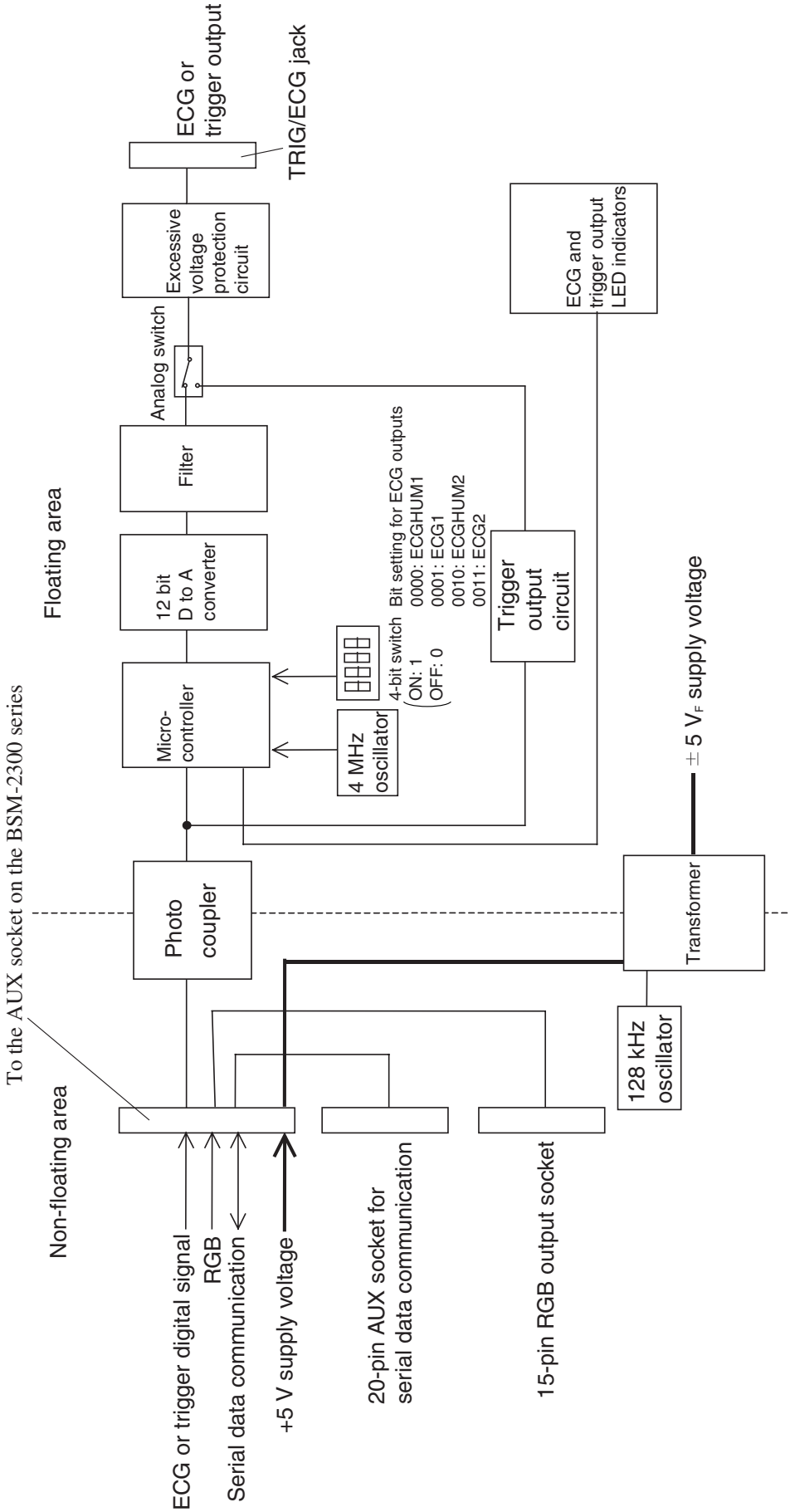
BSM-2351/2353/2354



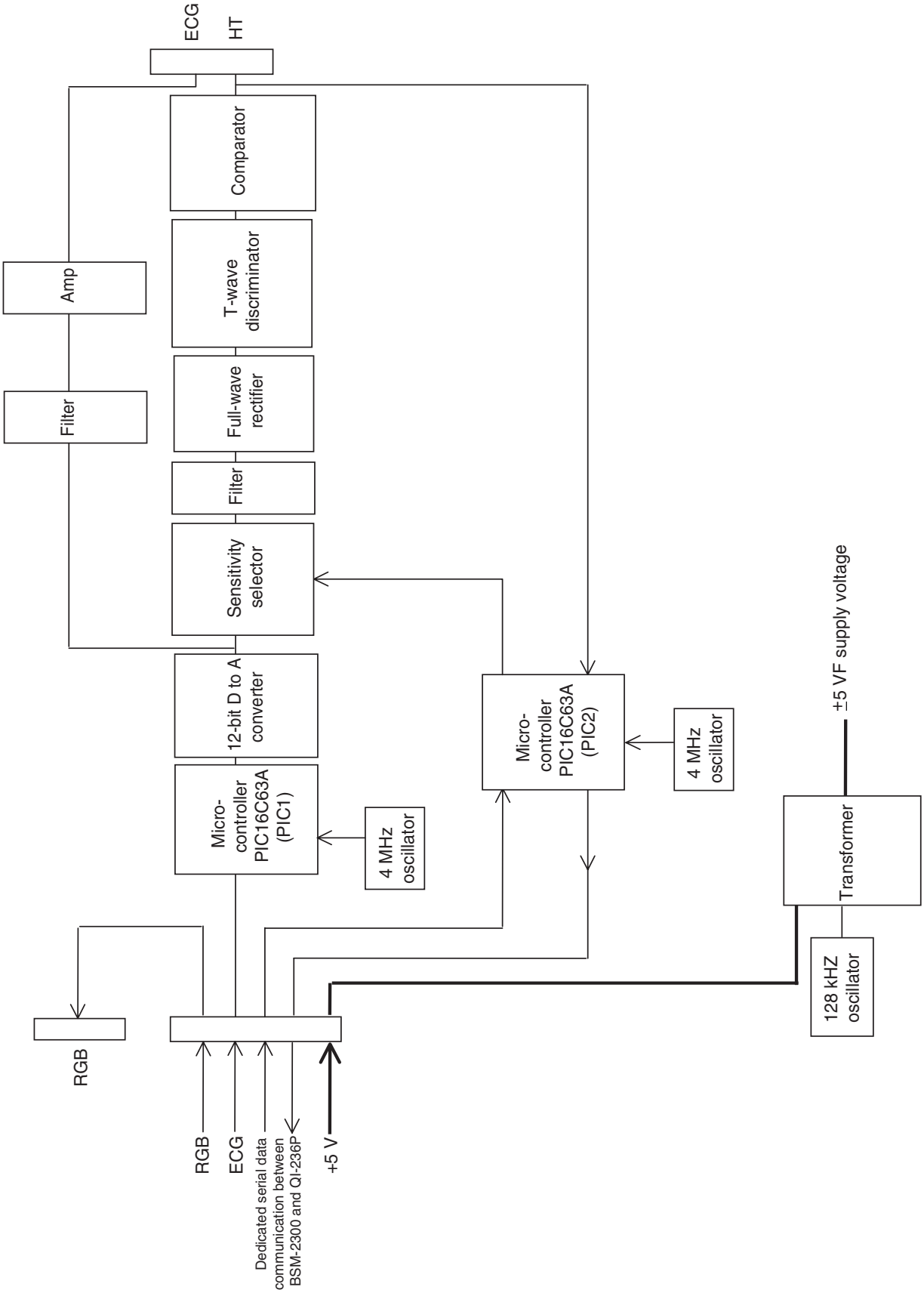
WS-231P Recorder Module



QI-231P Interface



QI-236P Interface



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Section 2 Troubleshooting

General 2.1
Power-Related Problems 2.2
Display Problems 2.3
Sound Problems 2.4
Key Operation Problems 2.4
ECG and Respiration by Impedance Method Problems 2.5
SpO_2 Problems 2.6
Non-invasive Blood Pressure Problems 2.7
Temperature Problems 2.8
Other Vital Sign Input Problems 2.9
Option Problems 2.10
Recording Problems 2.11
QI-231P Interface Problems 2.13
QI-236P Interface Problems 2.13

General

Use the troubleshooting tables to locate, identify and solve a problem in the instrument. The problems are divided into general problem areas. Each category has its own troubleshooting table for fast and easy troubleshooting.

- Power-related Problems
- Display Problems
- Sound Problems
- Key Operation Problems
- ECG and Respiration by Impedance Method Problems
- SpO_2 Problems
- NIBP Problems
- Temperature Problems
- Other Vital Sign Input Problems
- Option Problems
- Recording Problems

If these sections do not solve the problem, contact your Nihon Kohden representative.

NOTE

Before contacting your Nihon Kohden representative for technical support, please provide additional detailed information on the problem. This will allow your Nihon Kohden representative to provide you with the best support.

How to use the troubleshooting table

1. Determine which troubleshooting table to use.
2. In the “Problem” column, find the trouble item that matches the problem.
3. Do the action recommended in the “Action” column.
4. If the problem is not solved, do the action for the next possible cause or criteria.
5. If none of the actions solve the problem, contact your Nihon Kohden representative.

Power-Related Problems

Problem	Possible Cause/Criteria	Action
The instrument is not turned on and AC power lamp does not light in AC power operation.	No AC power input.	Check the AC power input.
	One or both AC inlet fuses is blown.	Remove the cause of the blown fuse, then replace the fuse with a new one.
	Faulty connection between CN0401 on the MAIN board and power supply unit.	Check the connection.
	Faulty power supply unit.	Replace the power supply unit with a new one.
	Faulty connection between CN0202 on the MAIN board and CN101 on the Operation board or between CN102 on the Operation board and CN103 on the Power SW board.	Check the connection.
	Faulty MAIN board.	Replace the MAIN board with a new one.
	Faulty Power SW board.	Replace the Power SW board with a new one.
The instrument is not turned on but AC power lamp lights in AC power operation.	Faulty Power SW board.	Replace the Power SW board with a new one.
	Faulty MAIN board.	Replace the MAIN board with a new one.
The instrument is not turned on and the battery power lamp does not light in DC power operation.	The battery is discharged.	Charge the battery before use.
	The battery is damaged or near the end of its life (about 1 year).	Replace the battery with a new one.
	Faulty connection between CN0202 on the MAIN board and CN101 on the Operation board or between CN102 on the Operation board and CN103 on the Power SW board.	Check the connection.
	Faulty MAIN board.	Replace the MAIN board with a new one.
DC power operation time is shorter than expected.	The battery is near the end of its life (about 1 year).	Replace the battery with a new one.
	The battery has had “memory effect” in which its charge capacity is decreased by frequent incomplete discharging and charging.	To clear this “memory effect”, fully discharge the battery and then fully charge it a few times.
		Replace the battery with a new one.
	Faulty battery charger circuit.	Replace the MAIN board with a new one.
Power switch is not operational.	Faulty Power SW board.	Replace the Power SW board.
	Faulty MAIN board.	Replace the MAIN board.

Display Problems

Problem	Possible Cause/Criteria	Action
No display and the backlight does not light.	Faulty connection between CN0802 on the MAIN board and inverter.	Check the connections.
	Faulty connection between inverter and LCD unit.	Check the connections.
	Faulty inverter board.	Replace the inverter board.
	Faulty backlight lamps.	Replace the backlight lamps.
No display, but the backlight lights.	Faulty connection between CN1001 on the MAIN board and LCD unit.	Check the connection.
	Faulty LCD unit.	Replace the LCD unit.
	Faulty MAIN board.	Replace the MAIN board.
The characters or waveforms are distorted.	Faulty MAIN board.	Replace the MAIN board.
The display is dim and the brightness control does not make it brighter.	Battery operation.	Set the POWER SAVE MODE to OFF on the SYSTEM SETUP screen.
	Dirt on the touch screen (inside or outside).	Clean the surface of touch screen.
	The backlight lamps are near the end of its useful life (50,000 hours of operation).	Replace the backlight lamps.
	Faulty connection between CN0802 on the MAIN board and inverter board.	Check the connection.
The Diagnostic Check screen appears in the monitor mode and “OK” is displayed at the POWER ON CHECK RESULT.	Faulty Operation board.	Replace the Operation board.
	Faulty MAIN board.	Replace the MAIN board.
The Diagnostic Check screen appears in the monitor mode and an error message is displayed at the POWER ON CHECK RESULT. Refer to “Power On Self Check” in Section 3.	Faulty MAIN board.	Replace the MAIN board.
	Faulty Analog board.	Replace the Analog board.
The screen with a “Check Program Running” message does not change to the next screen after the power is turned on.	Interference such as electrostatic discharge temporarily breaks the program data.	Perform the system initialization.
	Faulty MAIN board.	Replace the MAIN board.
	Faulty Analog board.	Replace the Analog board.
System error information appears at the upper left corner on the screen in the monitor mode and the instrument restarts.	Faulty MAIN board.	Replace the MAIN board.
More than 6 pixels on the screen do not light or have abnormal color. Note that up to 6 pixels with such a problem is considered normal.	Faulty LCD unit.	Replace the LCD unit.
No waveform is displayed but the connection cord for each vital sign is recognized.	Faulty MAIN board.	Replace the MAIN board.
No waveform is displayed and the connection cord for each vital sign is not recognized.	Refer to each vital sign troubleshooting section.	Refer to each vital sign troubleshooting section.

Sound Problems

Problem	Possible Cause/Criteria	Action
No sound.	Faulty connection between CN0107 on the NIBP board and the speaker.	Check the connection.
	Faulty speaker.	Replace the speaker.
	Faulty audio circuit on the MAIN board.	Replace the MAIN board.
No sound, except for a hissing sound.	Faulty audio circuit on the MAIN board.	Replace the MAIN board.
	Faulty speaker.	Replace the speaker.
The sound is muffled or distorted.	Something foreign blocks the speaker vents or touches the speaker.	Remove the foreign matter.
	The speaker is wrongly attached.	Attach the speaker correctly.

Key Operation Problems

Problem	Possible Cause/Criteria		Action
No key on the front panel works.	Faulty connection between CN101 on the Operation board and CN0202 on the MAIN board.		Check the connection.
	Faulty MAIN board.		Replace the MAIN board.
	Faulty Operation board.		Replace the Operation board.
A specified key on the operation panel does not work.	Faulty connection between CN101 on the Operation board and CN0202 on the MAIN board.		Replace the connection cable.
	Faulty Operation board.		Replace the Operation board.
	Faulty MAIN board.		Replace the MAIN board.
The workable key area does not match the key display on the screen.	Incorrect calibration of the touch screen.		Calibrate the touch screen positioning.
	Faulty MAIN board.		Check the MAIN board.
	Faulty touch screen.		Check the touch screen.
Touch screen does not work.	The key function on the entire screen does not work.	Faulty connection between the touch screen and CN0701 on the Connection board.	Check the connection.
		Faulty MAIN board.	Replace the MAIN board.
		Faulty touch screen.	Replace the touch screen.
	The key function on a partial screen such as upper half screen does not work	Faulty touch screen.	Replace the touch screen.

ECG and Respiration by Impedance Method Problems

Problem	Possible Cause/Criteria	Action
ATTACH ELECTRODES message is displayed even after each electrode contact part of the electrode lead is short-circuited.	The setting, Number of electrodes, is set to a higher number than the actual number of the electrodes.	Set the number of electrodes correctly.
	The electrode lead, ECG connection cord or patient cable is faulty.	Replace the accessory with a new one.
	Faulty Analog board.	Replace the Analog board with a new one.
Hum (line frequency noise) is on the ECG waveform.	The contact between the patient's skin and electrode is poor or gel of the electrode is dry.	Replace all the electrodes with new ones.
	An electric blanket is used on or near the patient.	Cover the blanket with a shielding sheet.
	The instrument uses the AC outlet connected to a equipment which has noise source.	Use a different AC outlet.
	The ground wire of the power cord has a poor contact between the instrument and ground facility or the ground facility is poor.	Check which part is not grounded and remove the cause.
	FILTERS on the ECG window is set to OFF.	Set the FILTERS to on.
	Faulty Analog board.	Replace the Analog board.
The time constant setting cannot be changed.	Faulty connection between the MAIN board and Analog board.	Check the connection.
	Faulty Analog board	Replace the Analog board.
Pacing spike is not detected.	PACING DETECTION on the ECG window is set to OFF.	Set the DETECTION to ON.
	Faulty Analog board.	Replace the Analog board.
The ECG waveform is displayed with a different ECG sensitivity from the sensitivity setting.	Faulty connection between the MAIN board and Analog board.	Check the connection.
	Faulty Analog board.	Replace the Analog board.
Monitoring lead setting cannot be changed.	Faulty connection between the MAIN board and Analog board.	Check the connection.
	Faulty Analog board.	Replace the Analog board.
Respiration waveform is not displayed.	Electrode, electrode lead, ECG connection cord or patient cable is faulty if the ECG waveform on the screen has something wrong.	Replace the accessory with a new one.
	When "RESP OFF" message is displayed on the screen, IMP RESP MEASURE on the RESP window is set to OFF.	Set the IMP RESP MEASURE to ON.
	Faulty Analog board.	Replace the Analog board.
Respiration rate is wrong.	The respiration waveform amplitude is too small to count the respiration rate.	Change the sensitivity so that the amplitude is larger than 10 mm on the screen.
	Faulty Analog board.	Replace the Analog board.
ECG waveform and respiration waveform are mixed.	Faulty Analog board.	Replace the Analog board.
Respiration waveform is saturated and does not return to the baseline position but the sensitivity is not too high.	Faulty Analog board.	Replace the Analog board.

SpO_2 Problems

Problem	Possible Cause/Criteria		Action
CHANGE PROBE message is displayed.	The probe is expired, damaged or defective.		Replace the probe with a new one.
	Faulty SpO2 connection cord.		Replace the connection cord with a new one.
There is no change on the screen when you connect the SpO2 connection cord to the SpO2 socket on the instrument.	Temperature and IBP can be measured.	Faulty Analog board	Replace the Analog board with a new one.
	Temperature and IBP cannot be measured.	Faulty Analog board or MAIN board.	Replace the faulty board with a new one.
DETECTING PULSE message is displayed.	The probe attachment site is not changed or the probe is not replaced with a new one.		Change the probe site or replace the probe with a new one.
	The probe attachment site is changed or replaced with a new one.	Faulty Analog board.	Replace the Analog board with a new one.
CANNOT DETECT message is displayed.	The probe attachment site is not changed or the probe is not replaced with a new one.		Change the probe site or replace the probe with a new one.
	The probe attachment site is changed or replaced with a new one.	Faulty Analog board.	Replace the Analog board with a new one.

Non-invasive Blood Pressure Problems

Problem	Possible Cause/Criteria	Action
NIBP MODULE ERROR message is displayed.	Faulty NIBP board.	Replace the NIBP board with a new one.
NIBP SAFETY CIRCUIT RUNNING message is displayed.	Air hose is bent.	Check the air hose.
	One of the internal air tubes between the NIBP board and NIBP socket is pinched.	Check the internal air tube connection.
	Faulty NIBP board.	Replace the NIBP board with a new one.
AIR LEAK message is displayed.	Cuff or air hose has an air leak.	Replace the cuff or air hose with a new one.
	One of the internal air tubes between the NIBP board and NIBP socket is loose or disconnected if the cuff is not inflated when the NIBP pump sounds like it's moving.	Check the internal air tube connection. Replace the faulty component with a new one if damaged.
	Faulty NIBP board.	Replace the NIBP board with a new one.
There is no change on the screen when you connect the air hose to the NIBP socket on the instrument.	The air hose connector is faulty.	Replace the air hose with a new one.
	The connection cable between the Hall Sensor board and NIBP board is disconnected or faulty.	Tightly connect the cable between the boards. Replace the cable with a new one if faulty.
	The connection cable between the NIBP board and MAIN board is disconnected or faulty.	Tightly connect the cable between the boards. Replace the cable with a new one if faulty.
	Faulty Hall Sensor board, NIBP board or MAIN board.	Replace the faulty board with a new one.
NIBP measurement data on the screen is wrong.	A wrong cuff size is used or the condition of the cuff wrapped around the patient's arm is not correct.	Check the cuff size and the wrapping condition. Replace the cuff with a new one I f necessary.
	Faulty NIBP board.	Replace the NIBP board with a new one.
The cuff does not inflate when you press the NIBP START/STOP key.	If a message is displayed on the screen, follow the message to solve the problem.	Refer to ERROR MESSAGES AND TROUBLESHOOTING section in the operator's manual.
	The Operation board or MAIN board is faulty or the cable between the Operation and MAIN boards or between the MAIN and NIBP boards is disconnected or faulty.	Replace the faulty board or cable with a new one. Tightly connect the cable between the two boards.
	Faulty NIBP board	Replace the NIBP board with a new one.

Temperature Problems

Problem	Possible Cause/Criteria	Action
The temperature value is not displayed.	Faulty temperature probe.	Replace the probe with a new one.
	Faulty Analog board.	Replace the Analog board with a new one.
The temperature value is wrong.	Faulty temperature probe.	Replace the probe with a new one.
	Faulty Analog board.	Replace the Analog board with a new one.

Other Vital Sign Input Problems

Problem	Possible Cause/Criteria	Action
There is no change on the screen when you connect the connection cord to the multi-parameter socket on the instrument.	Faulty connection cord.	Replace the connection cord with a new one.
	Faulty Analog board.	Replace the Analog board with a new one.
MPU MODULE ERROR message is displayed.	The connection between the MAIN board and Analog board is disconnected or faulty if this message always appears even after the instrument is turned off and on again.	Check the connection. Replace the faulty board with a new one if the connection is faulty.
	The Analog board is faulty if this message sometimes appears after the instrument is turned off and on again.	Replace the Analog board with a new one.
MPU FAILURE message is displayed.	Faulty Analog board.	Replace the Analog board with a new one.
Invasive blood pressure cannot be measured.	Faulty blood pressure transducer.	Replace the blood pressure transducer with a new one.
	Faulty connection cord.	Replace the connection cord with a new one.
	Faulty Analog board or IBP board*.	Replace the Analog board or IBP board* with a new one.
CHECK SENSOR message is displayed during the invasive blood pressure measurement.	Faulty blood pressure transducer.	Replace the blood pressure transducer with a new one.
	Faulty connection cord.	Replace the connection cord with a new one.
	Faulty Analog board.	Replace the Analog board with a new one.
Invasive blood pressure values are wrong.	Faulty blood pressure transducer.	Replace the blood pressure transducer with a new one.
	Faulty connection cord.	Replace the connection cord with a new one.
	Faulty Analog board or IBP board*.	Replace the Analog board or IBP board* with a new one.
Respiration by thermistor method cannot be measured.	Faulty respiration pickup (thermistor probe).	Replace the pickup with a new one.
	Faulty Analog board.	Replace the Analog board with a new one.
Thermistor method respiration waveform has something wrong on the screen.	Faulty respiration pickup (thermistor probe).	Replace the pickup with a new one.
	Faulty Analog board.	Replace the Analog board with a new one.
CO_2 cannot be measured.	Faulty CO_2 sensor.	Replace the CO_2 sensor with a new one.
	Faulty CO_2 adapter.	Replace the CO_2 adapter with a new one.
	Faulty Analog board.	Replace the Analog board.
CO_2 measurement data on the screen is wrong.	Faulty CO_2 sensor.	Replace the CO_2 sensor with a new one.
	Faulty CO_2 adapter.	Replace the CO_2 adapter with a new one.

* BSM-2301and BSM-2351 have no IBP board.

Option Problems

Problem	Possible Cause/Criteria		Action
The instrument does not transmit the patient's data at all with the optional transmitter ZB-900P.	The transmitter cable is disconnected from the instrument.		Tightly connect the transmitter to the instrument.
	ZB-800P transmitter is erroneously connected to the instrument.		Use ZB-900P transmitter.
	The channel for the transmitter is not set at the central monitor or telemetry system.		Set the channel correctly at the central monitor or telemetry system.
	Faulty transmitter, Analog board or MAIN board.		Replace the faulty transmitter or board with a new one.
The instrument has no communication with the other bedside monitors and central monitors.	The optional QI-101P network card is not installed into the instrument.		Insert the network card into the slot of the instrument completely.
	The network communicating symbol does not appear on the screen.	The network card is poorly inserted into the slot of the instrument.	Tightly insert the network card into the slot.
		The network cable such as 10Base-T cable is poorly connected between the network card and hub.	Tightly connect the network cable between the network card and hub.
		The hub connected to the instrument is not turned on or is faulty.	Turn on the hub. Replace the hub with a new one if the problem still exists after the power is turned on.
		The instrument is connected to the hub with 10Base-T cross wiring cable.	Use the correct wiring 10Base-T cable.
		The instrument is directly connected to the central monitor with 10Base-T straight wiring cable.	
		The network cable is faulty.	Replace the network cable with a new one.
		The network card or MAIN board is faulty.	Replace the faulty network card or MAIN board with a new one.

Recording Problems

Problem	Possible Cause/Criteria		Action
Recording paper does not feed properly.	Recording mark does not appear on the screen when the record key is pressed.	Faulty connection between CN104 on the REC Power board and REC Key board or between the REC Power and REC MAIN boards.	Check the connection and replace the connection cable with a new one if necessary.
		Faulty REC Key board.	Replace the REC Key board.
		Faulty REC MAIN board.	Replace the REC MAIN board.
		Faulty connection between the monitor and recorder module.	Check the connection.
	Paper magazine open mark appears on the screen.	Faulty connection between the REC Power board and recorder unit.	Check the connection and replace the connection cable with a new one if necessary.
		Faulty magazine position sensing micro switch of the recorder unit.	Replace the micro switch. Refer to Section 8 “Replaceable Parts List”.
		Faulty REC Power board.	Replace the REC Power board.
		Faulty REC MAIN board.	Replace the REC MAIN board.
	Out of paper mark appears on the screen.	Faulty connection between the REC Power board and recorder unit.	Check the connection and replace the connection cable with a new one if necessary.
		Faulty paper detector (LED and phototransistor assy) of the reorder unit.	Replace the paper detector. Refer to Section 8 “Replaceable Parts List”.
		Faulty REC Power board.	Replace the REC Power board.
		Faulty REC MAIN board.	Replace the REC MAIN board.
	Recording can be performed when the paper is manually pulled out after the record key is pressed.	Faulty connection between the REC Power board and recorder unit.	Check the connection and replace the connection cable with a new one if necessary.
		Faulty paper drive motor of the recorder unit.	Replace the motor. Refer to Section 8 “Replaceable Parts List”.
		Faulty REC Power board.	Replace the REC Power board.
		Faulty REC MAIN board.	Replace the REC MAIN board.
For page-dependent recording such as trendgraph and vital sign list, the recording does not start at the top of the page	Wrong position of the recording paper in the magazine.		Load the paper into the magazine correctly.
	Paper other than Nihon Kohden is used.		Use the Nihon Kohden paper.
	Detector for the black square on the paper is dirty.		Clean the detector.
The recorded data such as waveform and grid has a faint part on the paper.	Work-up is adhered to the thermal array head.		Clean the head.
	Paper other than Nihon Kohden is used.		Use the Nihon Kohden paper.
	Platen roller has a damage or is deformed.		Replace the roller.
	The supply voltage for thermal array head (+24 V DC) becomes a lower voltage.		Replace the REC Power board.
There is missing dots on the recorded data.	Faulty thermal array head if the dots are missed at the same position on the paper after the head is cleaned.		Replace the head.
Straight line is recorded at the same position on the paper.	Faulty thermal array head.		Replace the head.
There is different contrast between the upper half and lower half of the paper.	The thermal array head is incompletely attached to the recorder unit.		Attach the head correctly.

Problem	Possible Cause/Criteria		Action
The paper speed is unstable and waveform is compressed or extended on time scale.	Dirty gear or platen roller.		Clean the gear and platen roller.
	Faulty gear or platen roller.		Replace the faulty one.
	Unstable turn of the paper drive motor	Faulty REC Power board.	Replace the REC Power board.
		Faulty motor or recorder unit.	Replace the motor or recorder unit.
Abnormally loud rotating sound of the paper drive motor	Faulty gear or platen roller		Replace the faulty one.
No recording on the paper	The heat-sensitive side of the paper is not faced to the thermal array head.		Load the paper into the magazine correctly.
	Paper other than Nihon Kohden is used.		Use the Nihon Kohden paper.
	Faulty connection between the REC Power board and recorder unit.		Check the connection and replace the connection cable with a new one if necessary.
	The supply voltage for thermal array head (+24 V DC) becomes a lower voltage.		Replace the REC Power board.
	Faulty thermal array head.		Replace the head.

QI-231P Interface Problems

Problem	Possible Cause/Criteria	Action
QRS synchronous signal HT is not output but the ECG lamp is lit.	The output setting is wrong.	Select the QRS SYNC SIGNAL at the EXTERNAL OUTPUT of the OTHER SETUP items in the SYSTEM SETUP settings.
Alarm trigger signal is not output but the ECG lamp is lit.	The output setting is wrong.	Select the ALARM CRISIS or ALARM CRISIS & WARNING at the EXTERNAL OUTPUT of the OTHER SETUP items in the SYSTEM SETUP settings.
ECG analog signal is not output but the TRIG lamp is lit.	The output setting is wrong.	Select the ECG ANALOG OUT at the EXTERNAL OUTPUT of the OTHER SETUP items in the SYSTEM SETUP settings.
The ECG lamp and TRIG lamp are not lit	The cable of the QI-231P interface has a poor contact to the bedside monitor.	Check the connection between the bedside monitor and interface.
	The QI-231P has a malfunction.	Replace the IO ANALOG OUT board with a new one.
An external display connected to the QI-231P interface does not display any screen.	The cable of the QI-231P interface has a poor contact between the bedside monitor and external display.	Check the connection from the bedside monitor to the external display through the interface.
	The display requires the different specification from the RGB signals of the bedside monitor.	Select an external display which matches the RGB signal specification of the bedside monitor.
	The QI-231P has a malfunction.	Replace the IO ANALOG OUT board with a new one.
When the QI-231P is attached to the bedside monitor, its operation is wrong.	The QI-231P has a malfunction.	Replace the IO ANALOG OUT board with a new one.

QI-236P Interface Problems

Problem	Possible Cause/Criteria	Action
QRS synchronous signal HT is not output.	No QRS wave is detected at this interface.	Adjust the ECG sensitivity at the bedside monitor.
	The connection between the bedside monitor and interface is poor.	Firmly connect the cable of this interface to the AUX socket of the bedside monitor.
ECG analog signal is not output.	The connection between the bedside monitor and interface is poor.	Firmly connect the cable of this interface to the AUX socket of the bedside monitor.
An external display connected to the bedside monitor through this interface does not display any screen.	This interface has a poor contact between the bedside monitor and external display.	Check the connection from the bedside monitor to the external display through this interface.
	The RGB signal requirement of the external display does not match the RGB signal specification of the bedside monitor.	Select an external display which matches the RGB signal specification of the bedside monitor.
	This interface has a malfunction.	Replace the IO CT OUT board with a new one.
When this interface is attached to the bedside monitor, the bedside monitor's operation becomes wrong.	This interface has a malfunction.	Replace the IO CT OUT board with a new one.

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Section 3 Diagnostic Check

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Introduction

The instrument has two check programs which automatically or manually diagnose the instrument. The automatic check program (power on self check) is executed whenever the instrument is turned on. The manual check program can be executed at any time.

All errors detected during the power on self check, manual check, and any time in monitor mode are stored in an error history table that you can view.

The manual check, error history, system setup and initialization are accessed from the DIAGNOSTIC CHECK screen.

Power On Self Check

The following icon appears during the power on self check.

If no error is detected, the monitor mode begins and the patient monitoring display appears. If a serious error which does not allow the host CPU to execute the system program any more is detected, the screen changes to the following DIAGNOSTIC CHECK screen and the error mesage is displayed.

If a minor error such as “Backup data is damaged” is detected, the monitor mode begins and the patient monitoring display appears after the power on self check. The detected error is stored in the error history table. Refer to “Calling Up the Error History” section.

The MAIN board and Analog board are checked as follows:

- CPU ROM CHECK: Checks the system ROM for the host CPU on the MAIN board. The MAIN board will be faulty if an error which causes a screen problem is found.
- CPU RAM CHECK: Checks the system RAM for the host CPU and patient data storage. The MAIN board will be faulty if an error which causes a screen problem is found.
- DPU ROM CHECK: Checks the ROM for the CPU of the DPU on the MAIN board. The MAIN board will be faulty if an error which causes a screen problem or data/waveform display problem is found.
- DPU RAM CHECK: Checks the RAM for the CPU of the DPU on the MAIN board. The MAIN board will be faulty if an error which causes a screen problem or data/waveform display problem is found.
- APU ROM CHECK: Checks the ROM for the CPU of the APU on the Analog board. The analog board will be faulty if an error which causes a screen problem or data/waveform display problem is found.
- APU RAM CHECK: Checks the RAM for the CPU of the APU on the Analog board. The analog board will be faulty if an error which causes a screen problem or data/waveform display problem is found.
- CLOCK IC CHECK: Checks the real-time clock IC on the MAIN board. If the date or time is wrong, the clock IC is initialized. The MAIN board will be faulty if an error is found.
- E2PROM CHECK: Checks the backup memory for the system setup data storage. If the data is wrong, the memory is initialized. The MAIN board will be faulty if an error is found.

If a serious error is found in the abovementioned checks, the instrument displays the DIAGNOSTIC CHECK screen without displaying the patient monitoring screen.

The following data checks are also done. The data is corrected if necessary.

- BACK UP CHECK: Checks the backed up data. If the backed up data has something wrong, the data is initialized.
- TIME CHECK: Checks correctness of the time.
- GET TIME CHECK: Checks the period during the power off and adjusts the time data if it is wrong.

Calling Up the DIAGNOSTIC CHECK Screen

Use this screen to view the error history or perform manual check or system setup and initialization.

1. With the power off, press the Power switch while pressing the SILENCE ALARMS key. Continue pressing the SILENCE ALARMS key until the DIAGNOSTIC CHECK screen appears.

2. To exit the DIAGNOSTIC CHECK screen and return to the patient monitoring mode, touch the “MONITOR MODE” key.

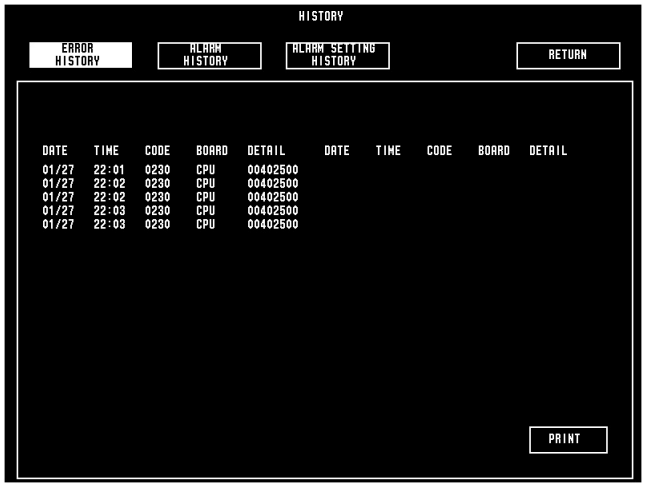
NOTE

After upgrading the instrument or adding the option to the instrument, check that the software version is changed to the new one or a model number of the option is displayed on the DIAGNOSTIC CHECK screen.

Calling Up the Error History

The ERROR HISTORY screen shows the error history of the instrument. The error code, board name, time, and date the error occurred are listed on this screen. For an explanation of error codes, see the "Error Codes" section. The error history data is deleted whenever system initialization is performed.

1. From the DIAGNOSTIC CHECK screen, touch the "HISTORY" key. The HISTORY screen appears. Then, touch the "ERROR HISTORY" key to display the error history.



2. Touch the "PRINT" key to print the screen with the recorder.

3. To return to the MANUAL CHECK MENU screen, touch the "RETURN" key.

Error Codes

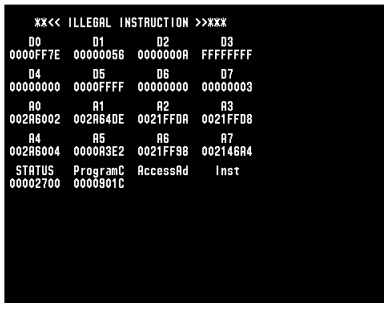
When a fault is detected during operation or during the power on self check, the error is stored in the error history table. The error codes stored in the error history are only deleted when system initialization is performed. If the memory space for the error history is filled up, however, the oldest error code is deleted when a new error code is added.

The message and description of each error code are described in the following table:

Error Code	Message	Description
0110	WATCH DOG ERROR	Interrupt from the watch dog timer
0210	BUS ERROR	Bus error occurred when an address which is not used in the program was selected
0220	ADDRESS ERROR	Address error when a word with an odd address is accessed

0230	ILLEGAL INSTRUCTION	Illegal command (not used in the program) is executed
0240	ZERO DIVIDE	Zero division error
0250	CHK INSTRUCTION	Check command error when the CHK command is executed
0260	TRAP INSTRUCTION	Trap command error when the TRAPV command is executed
0270	PRIVILEGE VIOLATION	Privilege error when the CPU is in the user mode and executes a supervisor command
0280	SPRIOUS INTERRUPT	Undefined interrupt error when the CPU receives an undefined interrupt request
0290	UNDEFINED AUTO VECTOR	Not used
02A0	UNDEFINED TRAP	Not used
02B0	UNDEFINED USER INT	Not used
02C0	OTHER ERROR	Errors other than the above mentioned errors
0310	OS ERROR	Error detected under the OS management
0400	OTHER	Error from faults other than those described above
0410	CPU (ROM)	Error detected by CPU ROM check
0411	WS (ROM)	Error detected by WS ROM check
0420	CPU (RAM)	Error detected by CPU RAM check
0440	A/D, D/A	Error detected by A/D and D/A check
0470	CLOCK	Error detected by the real time clock IC
0472	CLK DATA	Clock data error detected by CLOCK DATA check
0480	E2PROM	Error detected by EEPROM check
A410	DPU (ROM)	Error detected by DPU ROM check
A420	DPU (RAM)	Error detected by DPU RAM check
B410	APU (ROM)	Error detected by ROM check in the APU check.
B420	APU (RAM)	Error detected by RAM check in the APU check.

System Errors



A system error occurs when a fatal fault is detected during operation. All operation of the instrument is halted and the CPU operation status data at the system error appear on the left top of the screen. The system error is mostly stored in the error history table. In a few seconds after the status data is displayed, the instrument restarts. If the instrument repeats the restart, the MAIN board will be faulty.

Initializing the System

You can delete all stored waveforms and data and the error history and return all settings to the factory defaults.

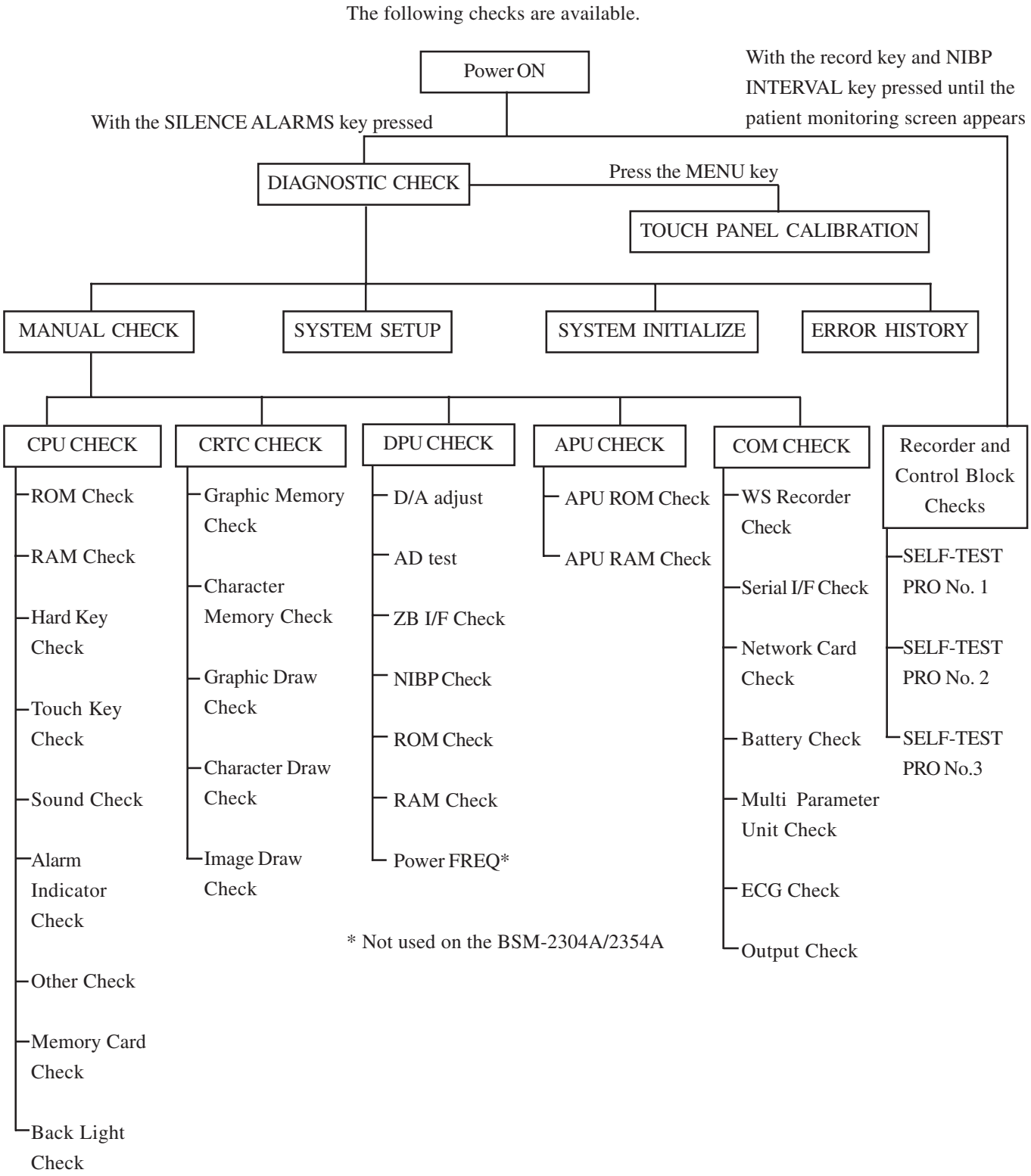
CAUTION

Initializing the system deletes all the patient data and error history, and returns the setting conditions to their default settings.

1. From the DIAGNOSTIC CHECK screen, touch the “SYSTEM INITIALIZE” key until a SYSTEM INITIALIZE confirmation message appears. (Approximately 3 seconds)
   All data and user settings are deleted.

2. To exit the DIAGNOSTIC CHECK screen and return to the patient monitoring mode, touch the “MONITOR MODE” key.

Performing Manual Check and Other Checks



In most of these checks, if a fatal error is detected during the check, the operating system hangs. When the system hangs, turn off the instrument and remove the cause.

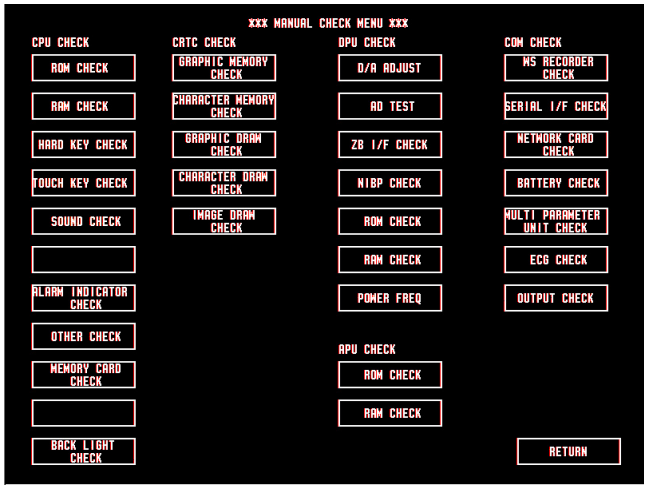
Calling Up the MANUAL CHECK MENU Screen

1. From the DIAGNOSTIC CHECK screen, touch the “MANUAL CHECK” key. The MANUAL CHECK MENU screen appears.

2. To test each item from the MANUAL CHECK MENU screen, touch a menu item key.

3. To return to the DIAGNOSTIC CHECK screen, touch the “RETURN” key.

4. To exit the DIAGNOSTIC CHECK screen and return to the patient monitoring mode, touch the “MONITOR MODE” key.



* POWER FREQ is not used on the BSM-2304A/2354A.

CPU Check Menu Items

The CPU check menu items check the function of the CPU peripherals such as ROMs, RAMs, switches, touch screen, sound generator, alarm indicator and external memory card.

ROM Check

This item checks the ROMs on the MAIN board by the CRC (cyclic redundancy check) technique. This check assigns a count number when one set of checks is successfully completed. A set of checks takes about 2 minute and 20 seconds.

If an error message appears, the MAIN board will be faulty.

Procedure to Start and Exit the ROM Check Program

1. To select the ROM Check, touch the “ROM CHECK” key. The instrument automatically starts the ROM check.

2. The instrument repeats the check and increments the pass count until you touch the “RETURN” key.

3. If the check program finds an error, it displays the type of ROM (PROGRAM or IMAGE) in the above area.

4. To return to the MANUAL CHECK MENU screen at any time, touch the “RETURN” key.

RAM Check

This item checks the RAM on the MAIN board by comparing the test patterns (first written to the RAM) with the test patterns (later read from the RAM). This test uses 15 test patterns and assigns a count number when a comparison of the 15 test patterns is successfully completed. The comparison of all the test patterns in this check takes about 4 minutes.

This check deletes the patient data. If an error message appears, the MAIN board will be faulty.

Procedure to Start, Stop, and Exit the RAM Check Program

1. To select the RAM Check, touch the “RAM CHECK” key. The instrument automatically starts the RAM check.

2. The instrument repeats the check and increments the pass count until the operator touches the “RETURN” key.

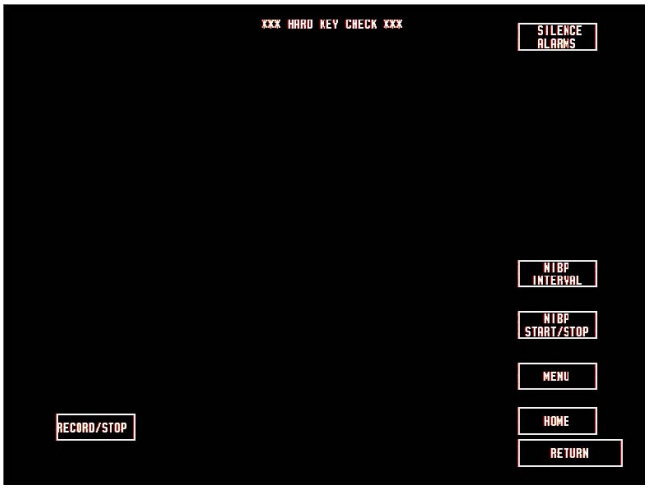
3. If the check program finds an error, it displays the address, write data and read data as shown in the above table.

4. To stop the check temporarily, touch the “STOP” key. The “START” key name changes to normal and the “STOP” key is highlighted.

   To continue the check, touch the “START” key again.

5. To return to the MANUAL CHECK MENU screen at any time, touch the “RETURN” key.

Hard Key Check



This item checks the operation of the hard keys on the front panel. The hard key layout appear. Pressing the hard key usually highlights the corresponding hard key on the screen.

If the pressed hard key is not highlighted, the key switch may be faulty. If more than one hard key has this symptom, the operation board or MAIN board will be faulty.

NOTE

The key does not give a key click sound when it is pressed in this check.

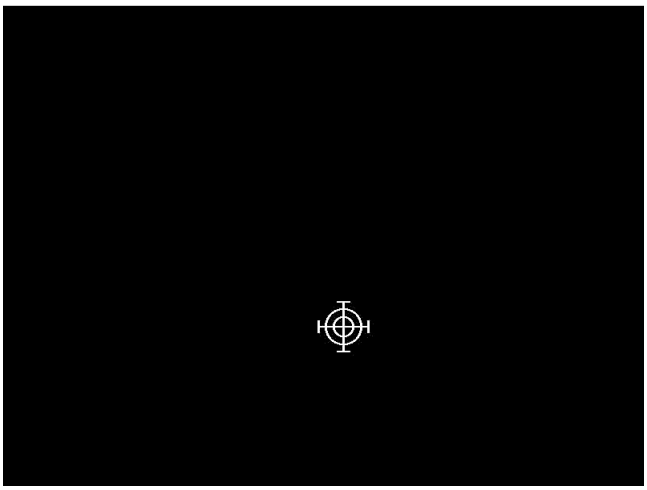
Procedure to Start the Check Keys or to Exit the Key Check Program

1. To check the hard keys, touch the “HARD KEY CHECK” key.

2. In the above screen, confirm that the corresponding pressed key is highlighted on the screen.

3. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

Touch Key Check



This item checks the touch key operation and positioning. When you start the check, the screen changes to the touch key check screen, and indicates the position where you touched. When you touch the screen and move your finger or touch pen, the target mark traces your position.

If the position of the target mark and the touched position do not match, calibrate the touch screen.

If you execute the touch key calibration and the position is still incorrect, the MAIN board or touch screen will be faulty.

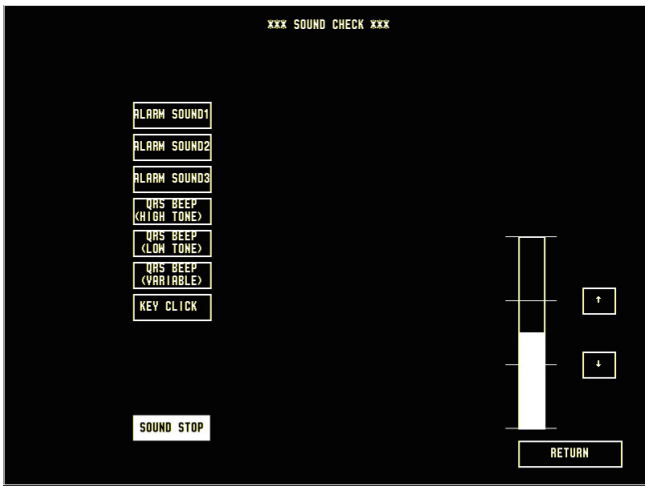
Procedure to Start the Touch Key Check or to Exit the Touch Key Check Program

1. To check the touch key, touch the “TOUCH KEY CHECK” key.

2. On the above screen, confirm that the touched position matches the target mark on the screen.

3. To return to the DIAGNOSTIC CHECK screen, press the HOME key.

Sound Check



This item checks the 7 types of sounds generated by the instrument. This check can also be used to check the alarm circuit and the QRS beep circuit. Check the quality of sound, loudness, noise, incorrect sound, etc.

If there is no sound or distorted sound, the speaker or MAIN board will be faulty.

Procedure to Check the Sound

1. To check the sound, touch the “SOUND CHECK” key.

2. Touch a sound key, such as “ALARM SOUND1”, “ALARM SOUND2”, “ALARM SOUND3”, “QRS BEEP (HIGH TONE)”, “QRS BEEP (LOW TONE)”, “QRS BEEP (VARIABLE)”, “KEY CLICK” to start the check for that sound.

3. To stop the check, touch the “SOUND STOP” key.

4. To change the sound volume, touch the “↑” or “↓” key.

5. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

ALARM INDICATOR Check

This item checks the function of the alarm indicator located on the top of the instrument. Check the light of indicator lamp according to the screen indication.

If the color does not light, the connection cable is loose or disconnected or the MAIN board or indicator board will be faulty. If the indicator lights partially, the indicator board is faulty.

Procedure to Start the ALARM INDICATOR Check Program

1. To select the Alarm Indicator Check, touch the “ALARM INDICATOR CHECK” key. The lighting color is highlighted on the screen sequentially.

2. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

OTHER Check

This item checks the clock IC and backup NVRAM (EEPROM). The NVRAM contains the system setup data. The check program checks that there is no difference between the data read from EEPROM and written data into EEPROM. Therefore, this check does not damage the system setup data. If the clock IC and NVRAM have no error, the "OK" message appears on the screen and current date and time appear at the top of the screen. If an error message appears, the MAIN board will be faulty.

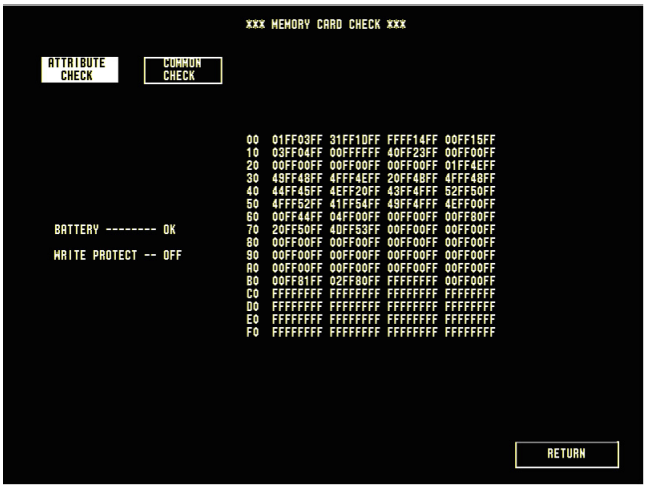
Procedure to Execute the OTHER Check Program

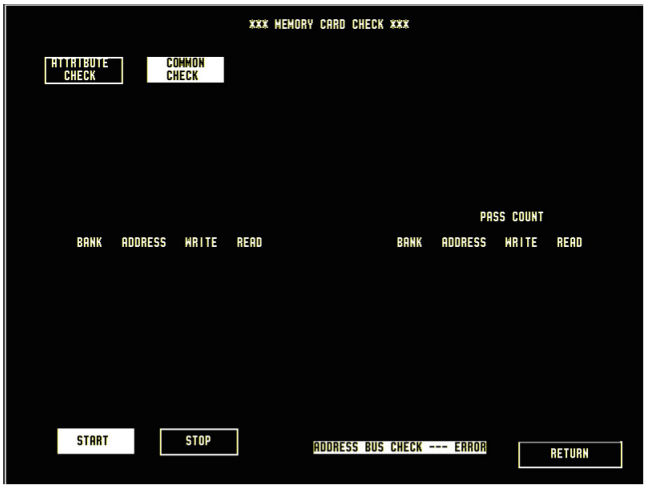
1. To select the OTHER Check, touch the "OTHER CHECK" key.

   The program starts the checking automatically and several minutes later, the program displays the result of checking.

2. To return to the MANUAL CHECK MENU screen, touch the "RETURN" key.

MEMORY CARD Check


xxx MEMORY CARD CHECK xxx
ATTRIBUTE CHECK
COMMON CHECK
00 01FF03FF 31FF1DFF FFFF14FF 00FF15FF
10 03FF04FF 00FFFFFF 40FF23FF 00FF00FF
20 00FF00FF 00FF00FF 00FF00FF 01FF4EFF
30 49FF48FF 4FFF4EFF 20FF4BFF 4FFF48FF
40 44FF45FF 4EFF20FF 43FF4FFF 52FF50FF
50 4FFF52FF 41FF54FF 49FF4FFF 4EFF00FF
60 00FF44FF 04FF00FF 00FF00FF 00FF80FF
70 20FF50FF 4DFF53FF 00FF00FF 00FF00FF
80 00FF00FF 00FF00FF 00FF00FF 00FF00FF
90 00FF00FF 00FF00FF 00FF00FF 00FF00FF
A0 00FF00FF 00FF00FF 00FF00FF 00FF00FF
B0 00FF81FF 02FF80FF FFFFFFFF 00FF00FF
C0 FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF
D0 FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF
E0 FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF
F0 FFFFFFFF FFFFFFFF FFFFFFFF FFFFFFFF
BATTERY -------- OK
WRITE PROTECT -- OFF
RETURN



This item checks the inserted PCMCIA card and its interface. There are two checks. The ATTRIBUTE CHECK displays the dump list of attribute area which is in the PCMCIA card. The COMMON CHECK is the write/read check for common area. This check continues until you touch the “STOP” key or “RETURN” key. The check method is the same as the system RAM check.

If the PCMCIA card is not inserted, the program displays the CARD NOT INSERTED message on the screen.

If an error is detected, the PCMCIA card or MAIN board will be faulty.

Procedure to Start MEMORY CARD Check Program

1. To select the MEMORY CARD Check, touch the “MEMORY CARD CHECK” key.

2. To display the dump list of attribute area which is in the memory card, touch the “ATTRIBUTE CHECK” key.

3. To start the common check, touch the “COMMON CHECK” key.

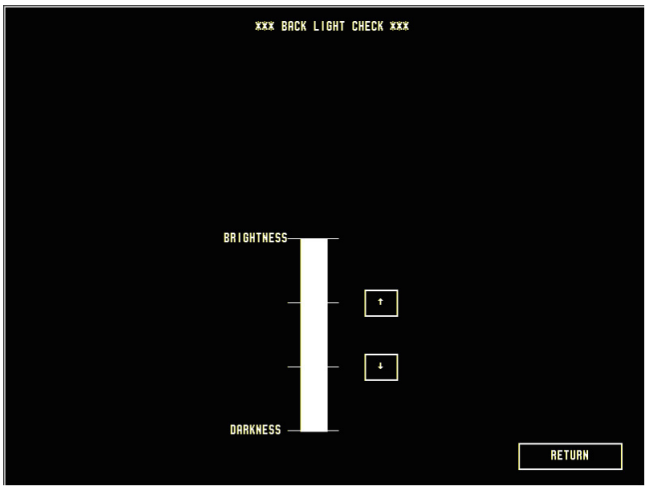
   If the check program finds an error, it displays the address, write data and read data as shown in the above table.

4. To stop the check temporarily, touch the “STOP” key. The “START” key name changes to normal and the “STOP” key is highlighted.

   To continue the check, touch the “START” key again.

5. To return to the MANAUL CHECK MENU screen, touch the “RETURN” key.

Backlight Check



This item checks the brightness control of the LCD backlight. While the brightness is manually changed, check that it changes smoothly with no twinkling. Check that the backlight goes off or has no twinkling when the brightness is set to minimum.

If the brightness does not change smoothly or the light goes off in the middle of the brightness bar on the screen, it indicates the end of life of the backlight or faulty inverter board.

In that case, replace the inverter board or fluorescent tube (backlight lamp) with a new one. Refer to Section 5 “Disassembly and Assembly”.

Procedure to Check the Brightness of the LCD Backlight

1. To select the Backlight Check, touch the “BACK LIGHT CHECK” key.

   To control the brightness, touch the bargraph or the “↑” or “↓” key to increase or decrease the brightness.

2. To return to the MANUAL CHECK MENU screen at any time, touch the “RETURN” key.

CRTC Check Menu Items

The CRTC check menu items check the function of the display control block, including the LCD unit. These check results cannot be recognized by the host CPU, so you must judge the result.

If an error is found, the MAIN board will be faulty.

GRAPHIC MEMORY Check and CHARACTER MEMORY Check

These items check the Graphic RAM and Character RAM on the MAIN board for the waveform display or character display by the write/read check technique. If an error is detected, the error bank, address and data are displayed as a table.

Procedure to Start the GRAPHIC MEMORY Check and CHARACTER MEMORY Check Program

1. To select the GRAPHIC MEMORY Check or CHARACTER MEMORY Check, touch the “GRAPHIC MEMORY CHECK” or “CHARACTER MEMORY CHECK” key.

   The “START” key is highlighted to indicate the process of checking.

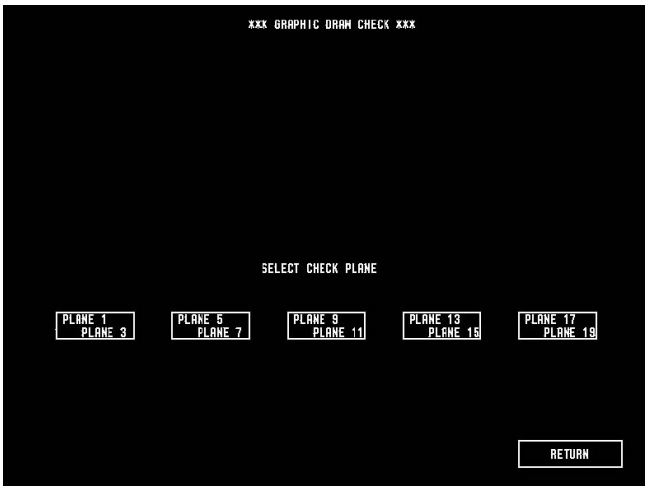
   If the check program finds an error, it displays the address (and block bank), write data and read data as shown in the above table.

2. To stop the check temporarily, touch the “STOP” key. The “START” key name changes to normal and the “STOP” key is highlighted.

   To continue the check, touch the “START” key again.

3. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

GRAPHIC DRAW Check



This item checks the function of the graphic draw plane. Check the figure of display and colors. The solid color screen allows you to find wrong LCD pixels.

10 planes for wave/graphic screen are available and the check program displays 2 planes at a time.

If the screen has a wrong display, the MAIN board or LCD unit will be faulty.

Procedure to Execute the GRAPHIC DRAW Check Program

1. To select the Check, touch the “GRAPHIC DRAW CHECK” key.

   Touch the “PLANE 1 - PLANE 3” to “PLANE 17 - PLANE 19” key on the screen to display the plane combination.

   When the program starts, it draws the grid line first.

2. To change the pattern to the triangular waveform, touch the screen.

   After touching the screen again, the screen shows you a solid color. The patterns are changed every time you touch the screen.

3. To change the plane combination, such as 2 planes or ALL, press the NIBP INTERVAL key.

   To change graphic color, press the SILENCE ALARMS key.

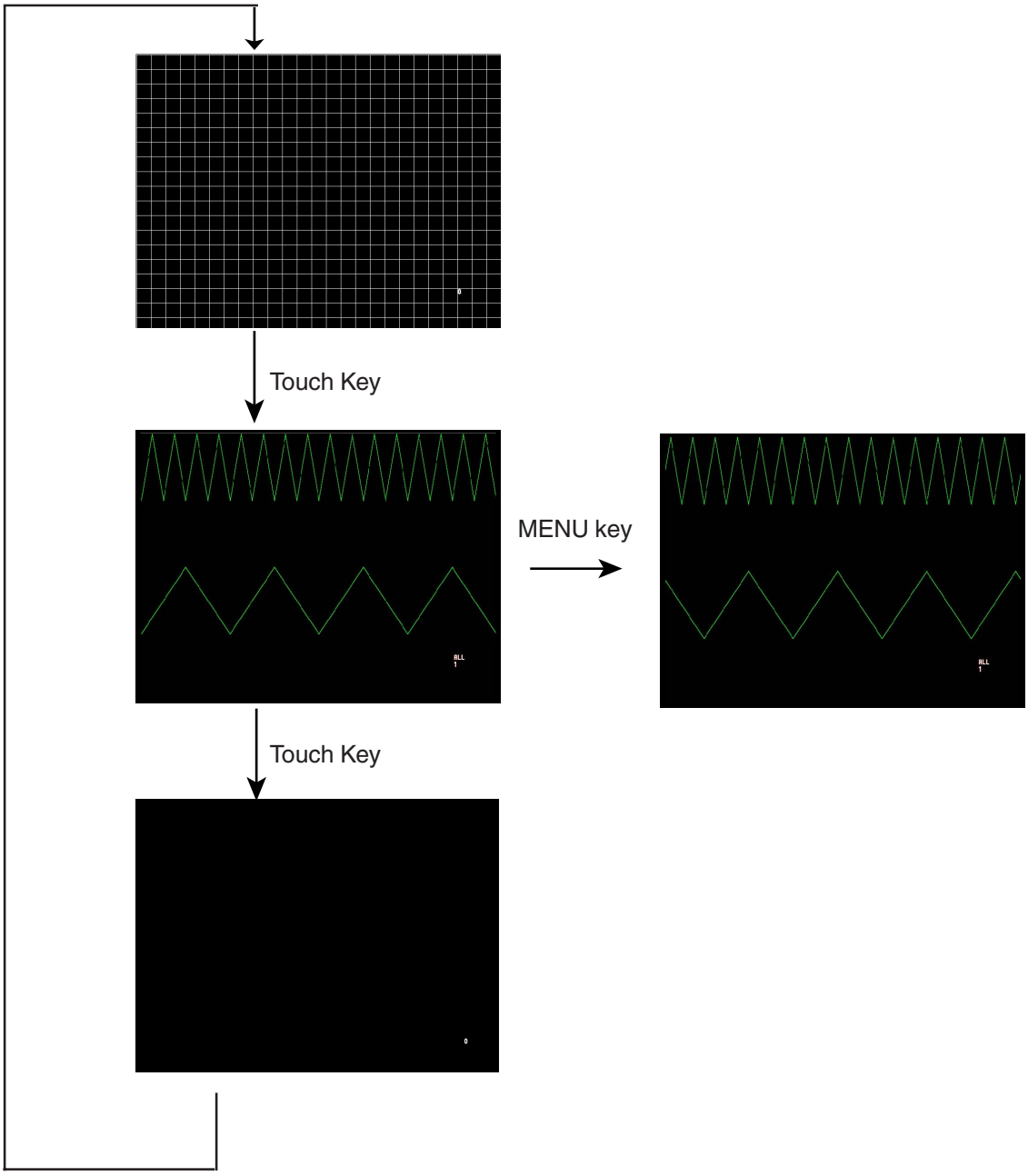
4. To scroll the waveform in the triangular waveform display mode, press the MENU key.

   Press the RECORD key to change the amplitude of each waveform.

5. To return to the GRAPHIC DRAW CHECK screen, press the HOME key.

6. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

Screen Flow of GRAPHIC DRAW Check Program



For the TFT LCD screen, it is considered normal if some pixels have randomly abnormal color or do not light. (Up to 6 wrong pixels are considered normal at the maximum brightness.)

CHARACTER DRAW Check

This item checks the function of the character draw plane and ASCII font display. Check the character display and colors. 2 planes for character screen are available and the check program displays one plane at a time.

If the screen has a wrong display, the MAIN board or LCD unit will be faulty.

Procedure to Execute the CHARACTER DRAW Check Program

1. To select the CHARACTER DRAW Check, touch the “CHARACTER DRAW CHECK” key and select a plane.

   When the program starts, it draws the green characters on the black plane.

2. To reverse the plane color, touch the “CHANGE BACK COLOR” key.

   If you press the MENU key, you can change the display mode in order of normal → blink → reverse → reverse and blink → normal.

3. To change the color of the character, press the SILENCE ALARMS key.

   The NIBP INTERVAL key selects another plane.

4. To return to the CHARACTER DRAW CHECK screen, press the HOME key.

5. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

Screen Flow of CHARACTER DRAW Check Program

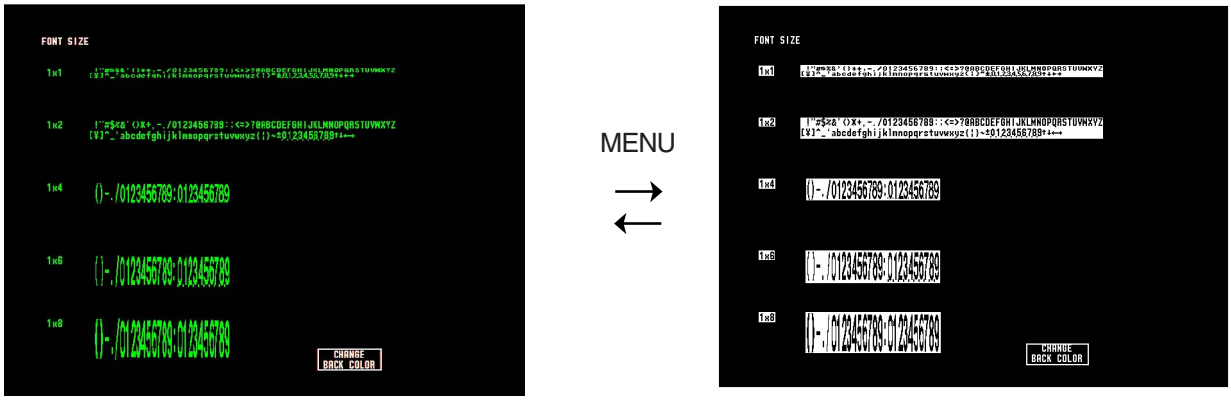
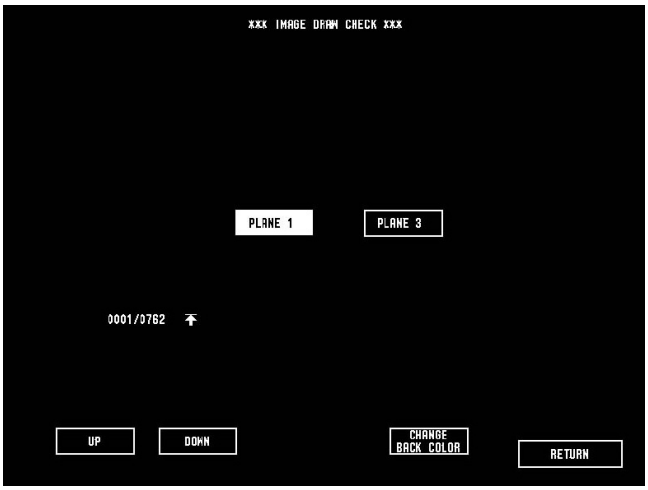


IMAGE DRAW Check



This item checks the function of the image draw plane and bit map character display. All the icons messages and bitmap images are displayed one by one. Check the image display and background colors.

If the screen has a wrong display, the MAIN board or LCD unit will be faulty.

Procedure to Start the IMAGE DRAW Check Program

1. To select the IMAGE DRAW Check, touch the “IMAGE DRAW CHECK” key.

   When the program starts, it draws the white image on the black plane.

2. To reverse the plane color, touch the “CHANGE BACK COLOR” key.

3. To change the images by ten, press the NIBP INTERVAL key.

   To change the image one by one, touch the “UP” or “DOWN” key on the screen.

4. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

DPU Check Menu Items

The DPU check items check the communication between the Analog board and DPU or between the NIBP board and DPU.

D/A ADJUST

This item is used to check the output voltage level of the D to A converter.

Connect a digital multimeter or oscilloscope to the ZB-900P socket (Pin 1: Analog output, Pin 2: Ground) and check the following output signals.

	D to A output
DC 2.5 V	2.500 V ±5%
DC 0 V CHECK	0 V ±100 mV
DC +5 V CHECK	+5.000 V ±5%
AC 30 Hz	30 Hz ±5%

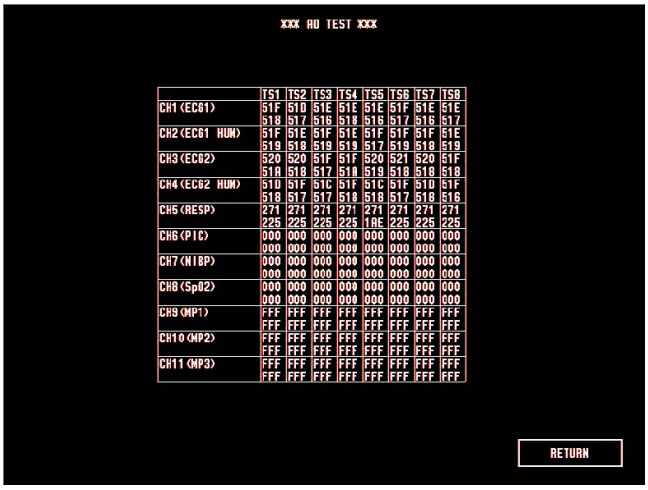
Procedure to Start the D/A Adjust Check

1. To select the D/A Adjust Check, touch the “D/A ADJUST” key at the DPU CHECK column. The program outputs 2.5 V DC.
   The “DC 2.5 V” key is highlighted to indicate the status of output.

2. To change the output voltage or waveform, touch each name of the other keys.

3. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

AD TEST



This is not a check. The AD Test table shows the A to D converted values of all the analog parameters such as ECG, SpO_2 and NIBP.

Each vital sign data are read from the A to D converter every 2 ms. The maximum and minimum data of each vital sign data are displayed every 512 ms.

CH1 (ECG1):	ECG1 waveform data with the hum filter set to off
CH2 (ECG1 HUM):	ECG1 waveform data with the hum filter set to on
CH3 (ECG2):	ECG2 waveform data with the hum filter set to off
CH4 (ECG2 HUM):	ECG2 waveform data with the hum filter set to on
CH5 (RESP):	Respiration waveform data
CH6 (PIC):	Not used
CH7 (NIBP):	NIBP measurement data
CH8 (SpO2):	Plethysmographic pulse wave data
CH9 (MP1):	Multi-parameter 1 socket input data
CH10 (MP2):	Not used
CH11 (MP3):	Not used

Procedure to start the AD Test

1. To select the AD Test, touch the “AD TEST” key at the DPU CHECK column. The program shows above table automatically.

2. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

ZB I/F Check

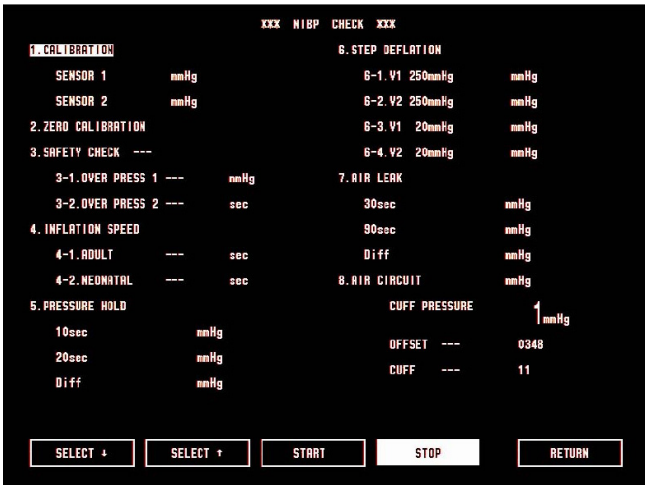
This check is used to check the signal lines when the ZB-900PG/K transmitter is connected to the instrument or the pins 2, 3 and 6 of the ZB socket short and pins 7 and 8 short for loop back test. If the signal lines have no problem, a “ZB CONNECTION” message appears. If there is a problem, a “ZB NO CONNECTION” message appears.

Procedure to start the ZB I/F Check

1. To select the ZB I/F Check, touch the “ZB I/F CHECK” key at the DPU CHECK column.

2. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

NIBP Check



This NIBP check program checks the two pressure sensors, safety opreation, pump, valves, air leakage and block. The check program consists of the following check items:

1. Calibration Sensor 1: Checks the pressure sensor for NIBP measurement circuit.
   Calibration Sensor 2: Checks the pressure sensor for NIBP safety circuit.
2. Zero Calibration: Checks the zeroing.
3. Safety Check: Checks the safety circuit operation.
   - 3-1 OVER PRESS1: Checks the pressure lmitter.
   - 3-2 OVER PRESS2: Checks the pressure continuous time.
4. Inflation Speed: Checks the time that the inflation pressure reaches to the specified pressure.
   - 4-1 Adult: Checks the inflation speed with 700 mL dummy cuff.
   - 4-2 Neonate: Check the inflation speed with 72 mL dummy cuff.
5. Pressure Hold: Checks that the inflation pressure is held for a specified time.
6. Step Deflation: Checks the valve operation.
7. Air leak: Not used.
8. Air Circuit: Checks that there is no air block.

To perform the check items, prepare the following tools:

Hand bulb pump
Mercury manometer
Y-branch connector (The Y-branch connector connects one tube of the dummy cuff to the hand bulb pump and manometer.)
700 mL dummy cuff YS-077P1 (A 700 ml dummy cuff is a solid container that withstands high pressure. The inner volume of this container must be 700 ml.)
250 mL dummy cuff YS-077P2
72 mL dummy cuff 6443-000022B
Two 3.5 m air hoses (YN-901P for adult/child and YN-921P for neonate)

Procedure to select the item and start the NIBP Check

1. To select the NIBP Check, touch the "NIBP CHECK" key at the DPU CHECK column. The program changes the screen to the NIBP CHECK.

2. Touch the "SELECT" key to select the check item number.

3. Touch the "START" key to start the check for the selected check item.

NOTE

Make sure there is no pressure applied on the cuff connector before pressing the "START" key. The program considers the pressure of the cuff connector as 0 mmHg at the start of the check.

4. To return to the MANUAL CHECK MENU screen, touch the "RETURN" key.

1. Calibration

The Calibration Check program is not used for calibration but is used to display the accuracy of the two pressure sensors (Sensor 1 and Sensor 2). The accuracy of each sensor changes with the measuring pressure. The following table shows the acceptable accuracy range of the two pressure sensors at different pressure ranges.

<Acceptable Accuracy Range of Sensor 1>

Pressure Range	Acceptable Accuracy Range
0 - 300 mmHg	±3 mmHg

<Acceptable Accuracy Range of Sensor 2 at Different Pressure Ranges>

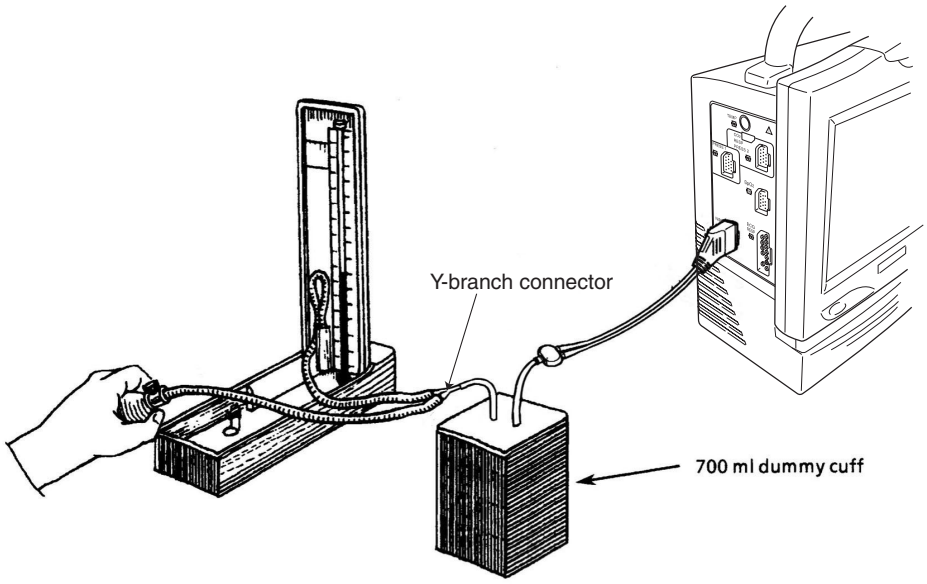
Pressure Range	Acceptable Accuracy Range
0 - 15 mmHg	–2 mmHg to +3 mmHg
16 - 200 mmHg	±8 mmHg
201 - 300 mmHg	±12 mmHg

Checking the Pressure Sensor Accuracy

NOTE

Before performing the following check, perform "2. ZERO CALIBRATION" first and check that "OK" appears on the screen.

1. Connect the manometer and hand bulb pump to the dummy cuff using the Y-branch connector and connect the dummy cuff to the instrument with the air hose as shown on the next page.



2. Touch the "SELECT ↑" or "SELECT ↓" key to select the "1. CALIBRATION" item.

3. Touch the "START" key to start the check.

4. Immediately start pumping the hand bulb pump. Stop pumping the hand bulb pump when the pressure reading displayed on the NIBP Check display of the instrument is within one of the above mentioned pressure ranges (0 to 300 mmHg at SENSOR1 or 0 to 15 mmHg, 16 to 200 mmHg or 201 to 300 mmHg at SENSOR 2).

5. Compare the pressure reading displayed on the NIBP Check display with the pressure reading on the manometer and check that the difference between the two pressure readings is within the acceptable accuracy range.

6. Repeat steps 4 and 5 for a reading in the other pressure range.

   If the accuracy of the pressure sensor for any of the two pressure ranges is out of the acceptable accuracy range, replace the NIBP board or pneumatic component such as air tube or valve with a new one.

2. Zero Calibration

This program is not used for calibration but is used for pressure zeroing.

Checking the Pressure Zeroing

NOTE

Do not connect any air hose to the NIBP socket on the instrument.

1. Touch the "SELECT ↑" or "SELECT ↓" key to select the "2. ZERO CALIBRATION" item.

2. Touch the "START" key to start the check.

3. Check that “OK” appears on the screen.

   If an error message apeears, replcae the NIBP board or pnuematic component such as pump or valve with a new one.

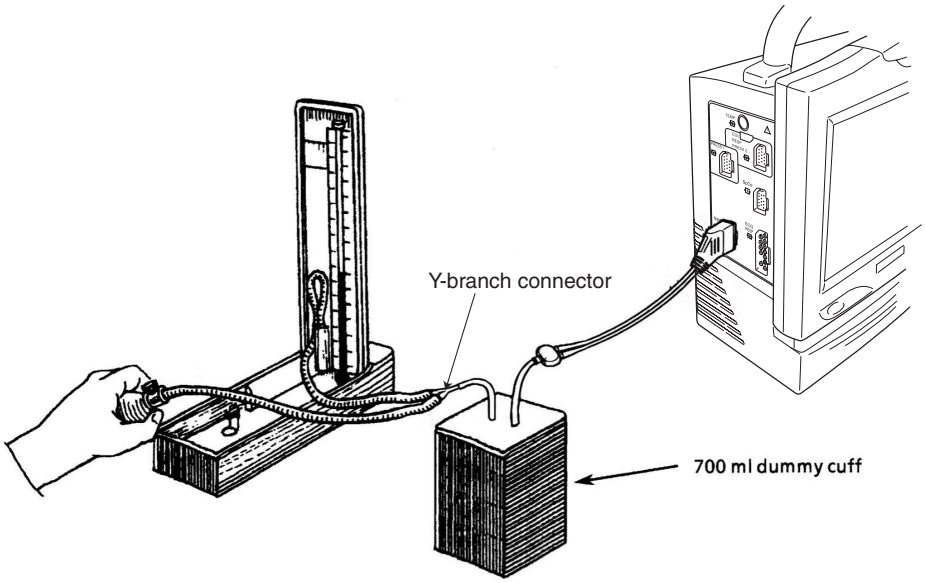
3. Safety Check

This check program has the following two check items.

3-1. OVER PRESS1

Checking the Safety Operation

1. Connect the manometer and hand bulb pump to the 700 mL or 72 mL dummy cuff using a Y-branch connector and connect the dummy cuff to the instrument with the 3.5 m long adult or neonatal air hose as shown below. The adult air hose must be used with the 700 mL dummy cuff and neonatal air hose must be used with the 72 mL dummy cuff.



2. Touch the “SELECT↑” key or “SELECT↓” key to select the “3-1. OVER PRESS1” item.

3. Touch the “START” key to start the check program.

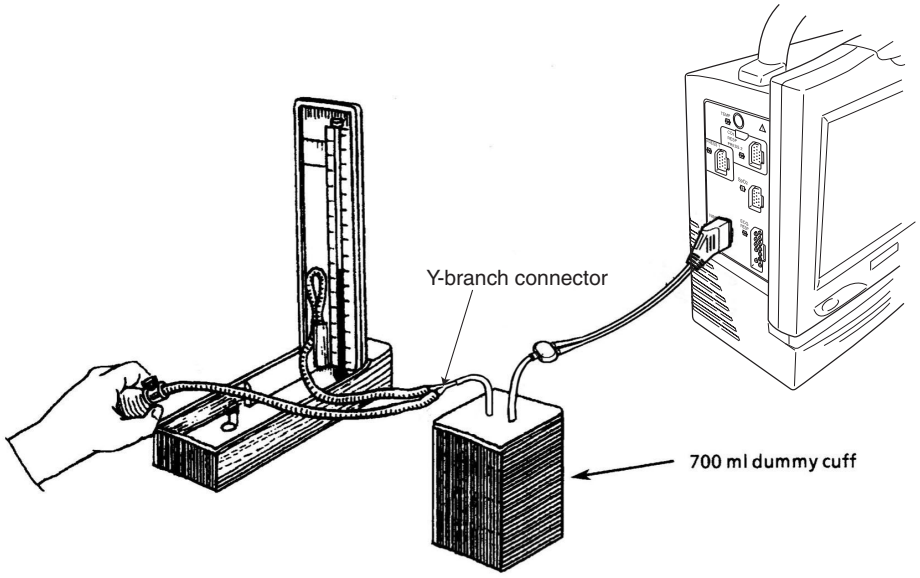
4. Immediately increase the pressure inside the dummy cuff and manometer with the hand bulb pump until the pressure reaches to 300 mmHg (for adult) or 150 mmHg (for neonate).

5. After getting the specified pressure, slowly increase the pressure with the hand bulb pump and check that the pressure is released within the range of 300 to 330 mmHg (for adult) or 150 to 165 mmHg (for neonate) by the safety valve.

3-2. OVER PRESS2

Checking the Safety Operation

1. Connect the manometer and hand bulb pump to the 700 mL or 72 mL dummy cuff using a Y-branch connector and connect the dummy cuff to the instrument with the 3.5 m long adult or neonatal air hose as shown below. The adult air hose must be used with the 700 mL dummy cuff and neonatal air hose must be used with the 72 mL dummy cuff.



2. Touch the "SELECT↑" key or "SELECT↓" key to select the "3-2. OVER PRESS2" item.

3. Touch the "START" key to start the check program.

4. Immediately increase the pressure inside the dummy cuff and manometer with the hand bulb pump until the pressure reaches to 300 mmHg (for adult) or 150 mmHg (for neonate).

5. After getting the specified pressure, stop pumping the hand bulb pump and check that the pressure is released within the range of 10 to 15 seconds by the time limiter and safety valve.

   If the abovementioned checks show an error, replace the NIBP board or pneumatic component such as valve and tube with a new one.

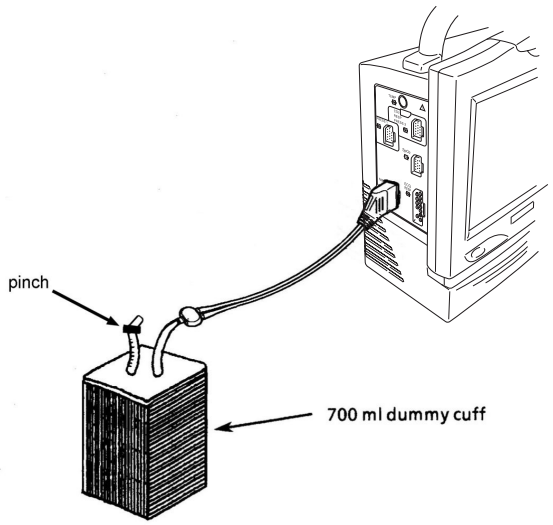
4. Inflation Speed

This check program has the following two check items.

4-1. ADULT

Checking the Inflation Speed

1. Connect the 700 mL dummy cuff to the instrument with the 3.5 m long adult/child air hose as shown below.



2. Touch the "SELECT↑" key or "SELECT↓" key to select the "4-1. ADULT" item.

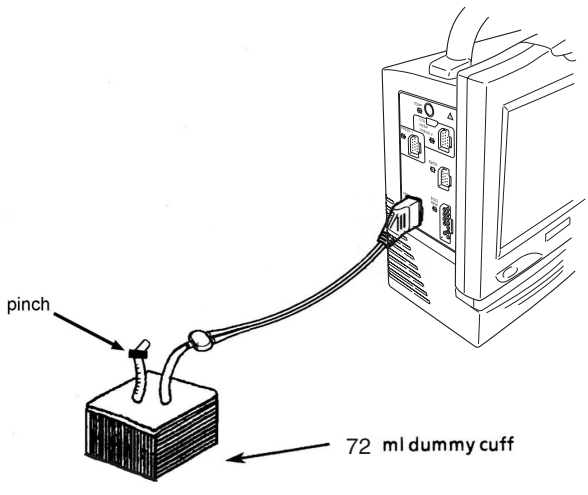
3. Touch the "START" key to start the check program. The instrument increases the pressure in the dummy cuff up to 200 mmHg.

4. Check that it takes 7 seconds or less to changes from zero pressure to 200 mmHg. If it takes more than 7 seconds, "ERROR" appears on the screen. In this case, replace the NIBP board or pneumatic component such as pump, valve or tube with a new one.

4-2. NEONATAL

Checking the Inflation Speed

1. Connect the 72 mL dummy cuff to the instrument with the 3.5 m long neonatal air hose as shown below.



2. Touch the "SELECT↑" key or "SELECT↓" key to select the "4-2. NEONATAL" item.

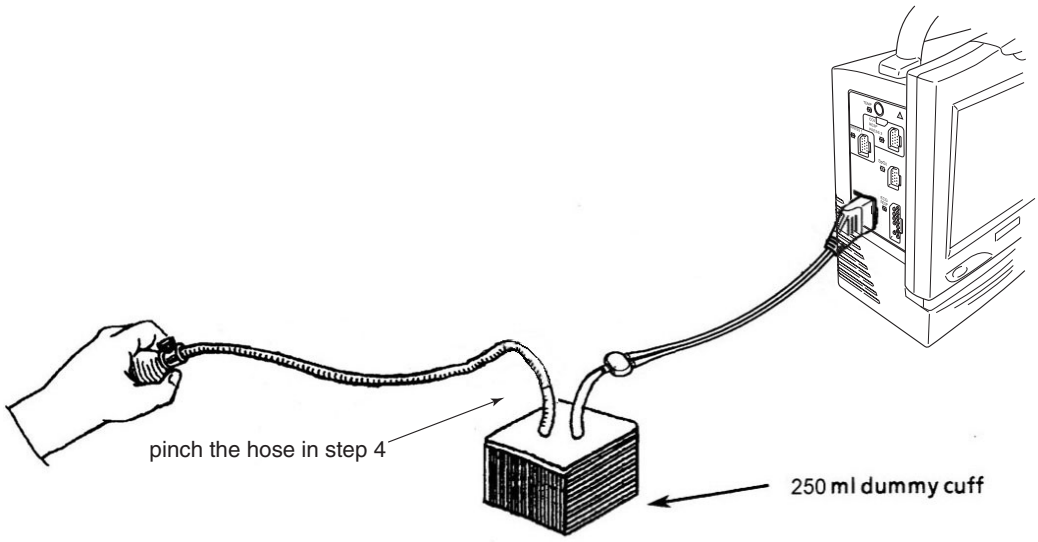
3. Touch the "START" key to start the check program. The instrument increases the pressure in the dummy cuff up to 200 mmHg.

4. Check that it takes 7 seconds or less to changes from zero pressure to 200 mmHg. If it takes more than 7 seconds, "ERROR" appears on the screen. In this case, replace the NIBP board or pneumatic component such as pump, valve or tube with a new one.

5. Pressure Hold

Checking the Pressure Hold

1. Connect the 250 mL dummy cuff and hand bulb pump to the instrument with the 3.5 m long adult/child air hose as shown below.



2. Touch the "SELECT↑" key or "SELECT↓" key to select the "5. PRESSURE HOLD" item.

3. Touch the "START" key to start the check program. The "START" key changes to "MEASURE START" key and blinks.

4. Immediately increase the pressure inside the dummy cuff with the hand bulb pump up to about 250 mmHg and pinch the hose of the hand bulb pump.

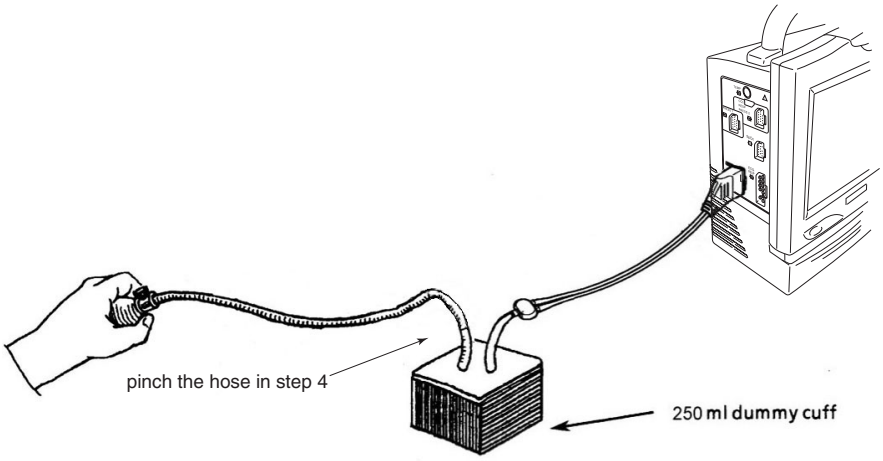
5. When the pressure becomes stable, touch the blinking "MEASURE START" key to measure the pressure. The blinking stops. The instrument displays the values of the pressure 10 seconds after and pressure 20 seconds after the "MEASURE START" key is pressed. Check that the pressure difference between the two pressures is within 5 mmHg. If it is more than 5 mmHg, an "ERROR" message appears and the NIBP board or pneumatic component such as pump, valve or tube is faulty.

6. Step Deflation

6-1. V1 250 mmHg

Checking the Valve 1 at the High Pressure

1. Connect the 250 mL dummy cuff and hand bulb pump to the instrument with the 3.5 m long adult/child air hose as shown below.



2. Touch the "SELECT↑" key or "SELECT↓" key to select the "6-1. V1 250mmHg" item.

3. Touch the "START" key to start the check program. The "START" key changes to "MEASURE START" key and blinks.

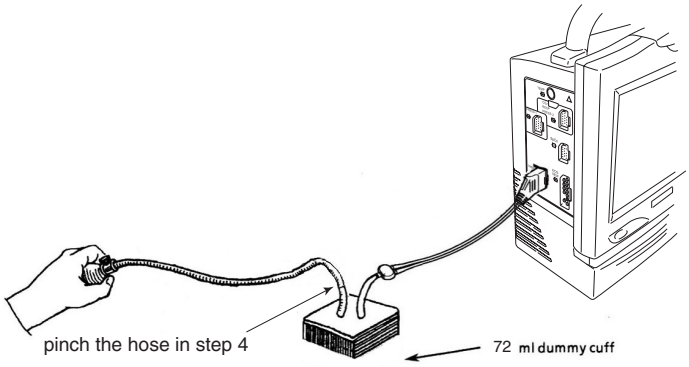
4. Immediately increase the pressure inside the dummy cuff with the hand bulb pump up to about 250 mmHg and pinch the hose of the hand bulb pump.

5. When the pressure becomes stable, touch the blinking "MEASURE START" key to measure the pressure. The blinking stops. The instrument displays the pressure value after the valve 1 opens for 50 milliseconds. Check that the pressure difference between the two pressures is within the range of 7 to 23 mmHg. If the pressure difference is out of the range, and "ERROR" message appears and the NIBP board or pneumatic component such as pump, valve or tube is faulty.

6-2. V2 250 mmHg

Checking the Valve 2 at the High Pressure

1. Connect the 72 mL dummy cuff and hand bulb pump to the instrument with the 3.5 m long adult/child air hose as shown below.



2. Touch the "SELECT↑" key or "SELECT↓" key to select the "6-2. V2 250mmHg" item.

3. Touch the "START" key to start the check program. The "START" key changes to "MEASURE START" key and blinks.

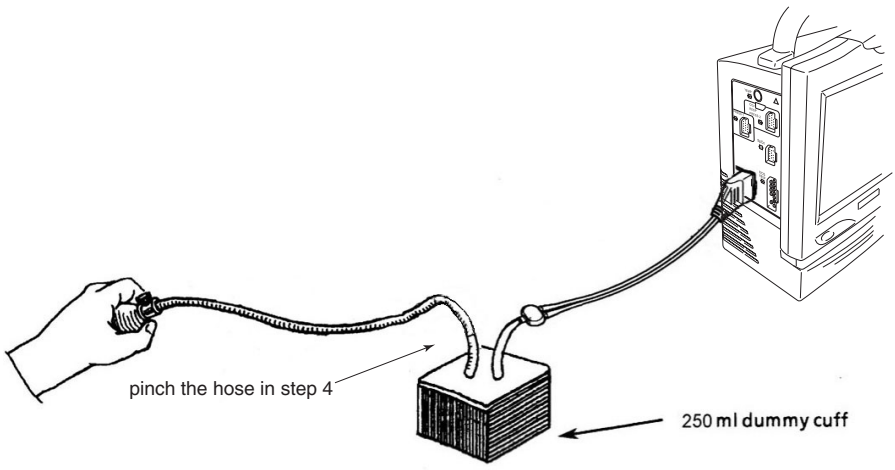
4. Immediately increase the pressure inside the dummy cuff with the hand bulb pump up to about 250 mmHg and pinch the hose of the hand bulb pump.

5. When the pressure becomes stable, touch the blinking "MEASURE START" key to measure the pressure. The blinking stops. The instrument displays the pressure value after the valve 2 opens for 50 milliseconds. Check that the pressure difference between the two pressures is within the range of 5 to 15 mmHg. If the pressure difference is out of the range, an "ERROR" message appears and the NIBP board or pneumatic component such as pump, valve or tube is faulty.

6-3. V1 20 mmHg

Checking the Valve 1 at the Low Pressure

1. Connect the 250 mL dummy cuff and hand bulb pump to the instrument with the 3.5 m long adult/child air hose as shown below.



2. Touch the "SELECT↑" key or "SELECT↓" key to select the "6-3. V1 20mmHg" item.

3. Touch the "START" key to start the check program. The "START" key changes to "MEASURE START" key and blinks.

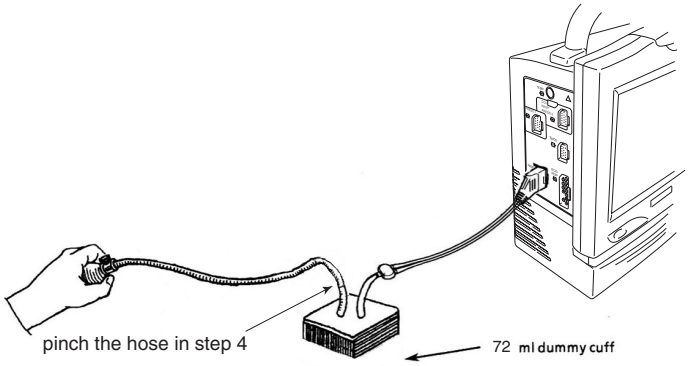
4. Immediately increase the pressure inside the dummy cuff with the hand bulb pump up to about 20 mmHg and pinch the hose of the hand bulb pump.

5. When the pressure becomes stable, touch the blinking "MEASURE START" key to measure the pressure. The blinking stops. The instrument displays the pressure value after the valve 1 opens for 120 milliseconds. Check that the pressure difference between the two pressures is within the range of 2 to 8 mmHg. If the pressure difference is out of the range, an "ERROR" message appears and the NIBP board or pneumatic component such as pump, valve or tube is faulty.

6-4. V2 20 mmHg

Checking the Valve 2 at the Low Pressure

1. Connect the 72 mL dummy cuff and hand bulb pump to the instrument with the 3.5 m long adult/child air hose as shown below.



2. Touch the "SELECT↑" key or "SELECT↓" key to select the "6-4. V2 20mmHg" item.

3. Touch the "START" key to start the check program. The "START" key changes to "MEASURE START" key and blinks.

4. Immediately increase the pressure inside the dummy cuff with the hand bulb pump up to about 20 mmHg and pinch the hose of the hand bulb pump.

5. When the pressure becomes stable, touch the blinking "MEASURE START" key to measure the pressure. The blinking stops. The instrument displays the pressure value after the valve 2 opens for 100 milliseconds. Check that the pressure difference between the two pressures is within the range of 2 to 8 mmHg. If the pressure difference is out of the range, an "ERROR" message appears and the NIBP board or pneumatic component such as pump, valve or tube is faulty.

7. Air Leak

Since "5. Pressure Hold" check covers this check which requires the special tool (not available locally), this check is not necessary for you.

8. Air Circuit

1. Disconnect any air hose from the NIBP socket on the instrument.

2. Touch the "SELECT↑" key or "SELECT↓" key to select the "8. AIR CIRCUIT" item.

3. Touch the "START" key to start the check program. The pump works.

4. Check that "OK" message appears on the screen after about 5 seconds.

   If "ERROR" message appears, the pneumatic component such as pump, valve or tube will be faulty.

DPU ROM Check

This item checks the ROM in the DPU on the MAIN board by the CRC (cyclic redundancy check) technique. This check assigns a count number when one set of checks is successfully completed.

If an error message appears, the MAIN board will be faulty.

Procedure to Start and Exit the DPU ROM Check Program

1. To select the DPU ROM Check, touch the “ROM CHECK” key at the DPU CHECK column.

   The instrument repeats the check and increments the pass count until you touch the “RETURN” key.

   If the check program finds an error, it displays the “ERROR” message on the screen.

2. To return to the MANUAL CHECK MENU screen at any time, touch the “RETURN” key.

DPU RAM Check

This item checks the RAM in the DPU on the MAIN board by comparing the test patterns (first written to the RAM) with the test patterns (later read from the RAM).

If an error message appears, the DPU board will be faulty.

Procedure to Start, Stop, and Exit the DPU RAM Check Program

1. To select the DPU RAM Check, touch the “RAM CHECK” key at the DPU CHECK column. The check program automatically starts.
   The “START” key is highlighted to indicate the process of checking.

   If the check program finds an error, it displays the address, written data and read data on the screen.

2. To stop the check temporarily, touch the “STOP” key. The highlighted “START” key changes to normal and the “STOP” key is highlighted.

   To resume the check, touch the “START” key again.

3. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

Power FREQ

This check program detects the line frequency and shows it.

Not used on the BSM-2304A/2354A.

APU Check Menu Items

The APU check items check the APU on the Analog board.

APU ROM Check

This item checks the ROM in the APU on the Analog board by the CRC (cyclic redundancy check) technique. This check assigns a count number when one set of checks is successfully completed.

If an error message appears on the screen, the Analog board will be faulty.

Procedure to Start and Exit the APU ROM Check Program

1. To select the APU ROM Check, touch the “ROM CHECK” key at the APU CHECK column.

   The instrument repeats the check and increments the pass count until you touch the “RETURN” key.

   If the check program finds an error, it displays the “ERROR” message on the screen.

2. To return to the MANUAL CHECK MENU screen at any time, touch the “RETURN” key.

APU RAM Check

This item checks the RAM in the APU on the Analog board by comparing the test patterns (first written to the RAM) with the test patterns (later read from the RAM).

If an error message appears on the screen, the Analog board will be faulty.

Procedure to Start, Stop and Exit the APU RAM Check Program

1. To select the APU RAM Check, touch the “RAM CHECK” key at the APU CHECK column. The check program automatically starts. The “START” key is highlighted to indicate the process of checking.

   If the check program finds an error, it displays the address, written data and read data on the screen.

2. To stop the check temporarily, touch the “STOP” key on the screen. The highlighted “START” key changes to normal and the “STOP” key is highlighted.

   To resume the check, touch the “START” key again.

3. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

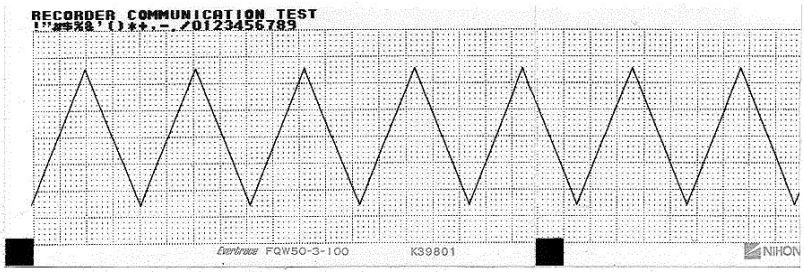
COM Check Menu Items

The COM check items check the communication between the host CPU and recorder CPU and serial communication at the AUX socket.

WS RECORDER Check

This item checks the dual port RAM in the ASIC (RACOON) and recorder CPU peripherals with the communication between the host CPU and recorder CPU. The optional recorder is one of the peripherals for the host CPU.

If an error is found, the MAIN borad or REC MAIN board will be faulty.



Procedure to Start the WS RECORDER Check Program

1. To select the WS RECORDER Check, touch the “WS RECORDER CHECK” key at the COM CHECK column.

2. Touch the PRINT TEST PATTERN “START” key. The host CPU communicates with the recorder CPU so that the above test pattern is recorded on the paper.

   The “START” key is highlighted to indicate the process of checking.

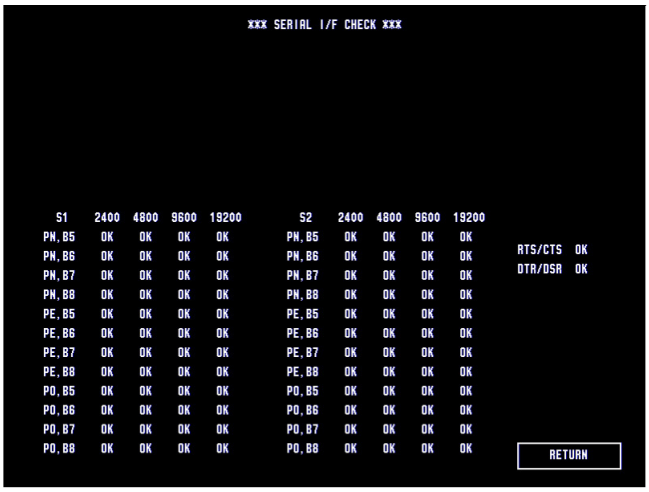
   Until you touch the “STOP” key, paper runs continuously.

   If the magazine is open or there is no paper, these status are displayed on the screen. If the status is not displayed in such condition, the MAIN board, REC MAIN board or recorder unit will be faulty.

SERIAL I/F Check

This item checks the serial communication interface for external equipment such as a personal computer.

To perform this check without a personal computer, you must make the following short circuits at the AUX socket.
Pins 8 and 18
Pins 9 and 19
Pins 10 and 20


xxx SERIAL I/F CHECK xxx
S1 2400 4800 9600 19200
PN,B5 OK OK OK OK
PN,B6 OK OK OK OK
PN,B7 OK OK OK OK
PN,B8 OK OK OK OK
PE,B5 OK OK OK OK
PE,B6 OK OK OK OK
PE,B7 OK OK OK OK
PE,B8 OK OK OK OK
PO,B5 OK OK OK OK
PO,B6 OK OK OK OK
PO,B7 OK OK OK OK
PO,B8 OK OK OK OK
S2 2400 4800 9600 19200
PN,B5 OK OK OK OK
PN,B6 OK OK OK OK
PN,B7 OK OK OK OK
PN,B8 OK OK OK OK
PE,B5 OK OK OK OK
PE,B6 OK OK OK OK
PE,B7 OK OK OK OK
PE,B8 OK OK OK OK
PO,B5 OK OK OK OK
PO,B6 OK OK OK OK
PO,B7 OK OK OK OK
PO,B8 OK OK OK OK
RTS/CTS OK
DTR/DSR OK
RETURN

Procedure to Start the SERIAL I/F Check Program

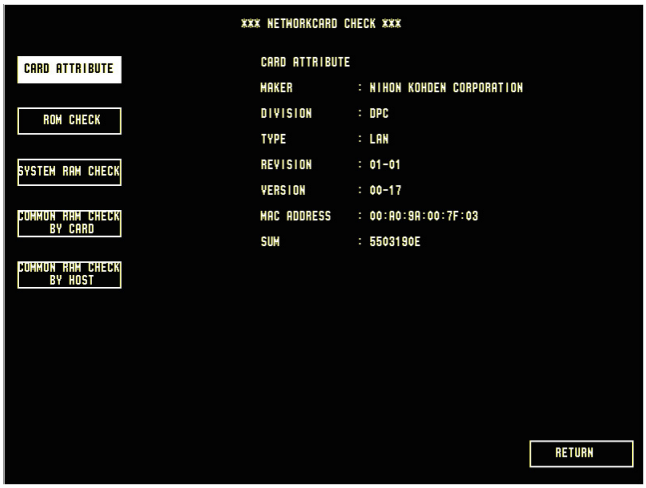
To select the SERIAL I/F Check, touch the “SERIAL I/F CHECK” key at the COM CHECK column. The check program automatically starts.

To check the serial communication interface, the check program changes the baud rate, data bit length and parity check condition.

If an error message appears, the MAIN board will be faulty.

NETWORK CARD Check

This item checks the QI-101P network card and its interface. To perform this check, the optional QI-101P network card is required.



Procedure to Start the NETWORK CARD Check Program

1. To select the NETWORK CARD Check, touch the "NETWORK CARD CHECK" key at the COM CHECK column.

   The check program recognizes the type of card and displays the attribute data which is memorized in the card.

   If the QI-101P network card is not inserted, the "INSERT NETWORK CARD" message appears on the screen instead of the above screen example. At that time, when you insert the network card, a few seconds later, the above screen appears automatically.

   If the check program can read the attribute data at the CARD ATTRIBUTE correctly and there is no error at the attribute data at COMMON RAM CHECK BY HOST but the instrument has no communication with the network, the network cable or hub will be faulty. If an error message appears at one of the five checks, the network card or MAIN board will be faulty.

2. Touch the "ROM CHECK" key on the screen. The CPU of the network card checks the program data of the ROM in the CPU using the check sum method and displays the check result on the following screen.

- CHECK: Displays the check result, i.e. “OK” or “ERROR”. When the CALCULATED SUM data is same as the SUM data, “OK” appears.
- SUM: The sum data of the program data stored in the ROM
- CALCULATED SUM: The sum data calculated from the program data in the ROM

3. Touch the “SYSTEM RAM CHECK” key on the screen. The CPU of the network card checks the system RAM in the CPU by writing the check data as a pattern and reading the stored check data and comparing the written data with the read data. If an error is found, the host CPU on the MAIN board displays the address at the error occurrence, written data and read data on the following screen.

4. Touch the “COMMON RAM CHECK BY CARD” key on the screen. The CPU of the network card checks the common memory of the network card. The host CPU on the MAIN board receives the check result and displays it on the screen. If an error is found, the host CPU displays the address at the error occurrence, written data and read data on the following screen.

5. Touch the “COMMON RAM CHECK BY HOST” key on the screen. The host CPU on the MAIN board checks the common memory of the network card and displays the check result on the screen. If an error is found, the host CPU displays the address at the error occurrence, written data and read data on the following screen.

6. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

BATTERY Check

This check program checks the temperature of the optional battery pack and thermistor for the battery temperature detection. If “DISCONNECTION” appears at the “THERMISTOR” check item but the battery pack is firmly connected, the battery pack or MAIN board will be faulty.

Procedure to Start and Exit the BATTERY Check Program

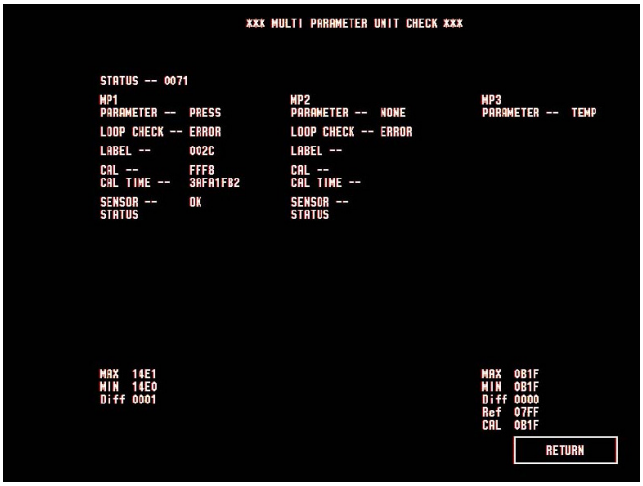
1. To select the BATTERY Check, touch the “BATTERY CHECK” key at the COM CHECK column. The program automatically starts and check results appear on the screen.

2. To return to the MANUAL CHECK MENU screen, touch the “RETURN” key.

MULTI PARAMETER UNIT Check

This item checks the communication between the DPU and APU and function of the multi-parameter input and IBP board*. The APU sends the check result and multi-parameter socket status data to the DPU on the MAIN board.

* BSM-2301 and BSM-2351 have no IBP board.



Procedure to Start and Exit the MULTI PARAMETER UNIT Check Program

1. To select the MULTI PARAMETER UNIT Check, touch the “MULTI PARAMETER UNIT CHECK” key at the COM CHECK column.

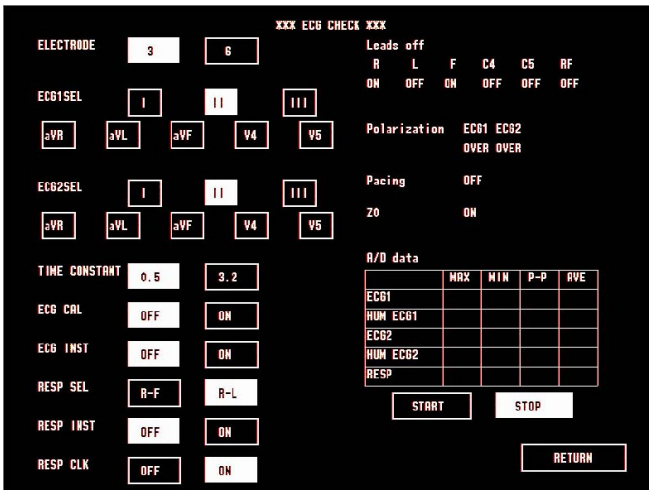
- STATUS: Factory use
- MP PARAMETER: Shows the vital sign parameter, i.e. PRESS, TEMP, CO_2, RESP, CO or FiO_2 when the corresponding connection cord is connected to the multi-parameter socket or IBP connection cord is connected to the PRESS1 socket. When the connection cord is disconnected from the socket, “NONE” message appears.
- LOOP CHECK: Shows “OK” message when the pins 6 and 7 of the multi-parameter socket short-circuits. Without this short circuit, “ERROR” message appears.
- LABEL: Shows the hexadecimal codes of the memorized BP site label when the IBP connection cord is connected to the multi-parameter socket.
- CAL: Shows the hexadecimal codes of the calibration value memorized on the EEPROM in the connection cord connector.
- CAL TIME: Shows the time that the latest calibration is done.
- SENSOR STATUS: Shows the status of the transducer or sensor connected to the multi-parameter socket through the connection cord. When a wire from the sensor or transducer is cut, “ERROR” message appears.

ECG Check

This check is for factory use.

NOTE

These ECG monitoring settings do not affect the monitor mode.



OUTPUT Check

When the optional QI-231P interface is connected to the bedside monitor, this check program shows that the interface LED lamp selected on this screen is lit. When the “ANALOG” is selected on the screen, the ECG lamp on the interface is lit. When the “TRIGGER” is selected on the screen, the TRIG lamp on the interface is lit.

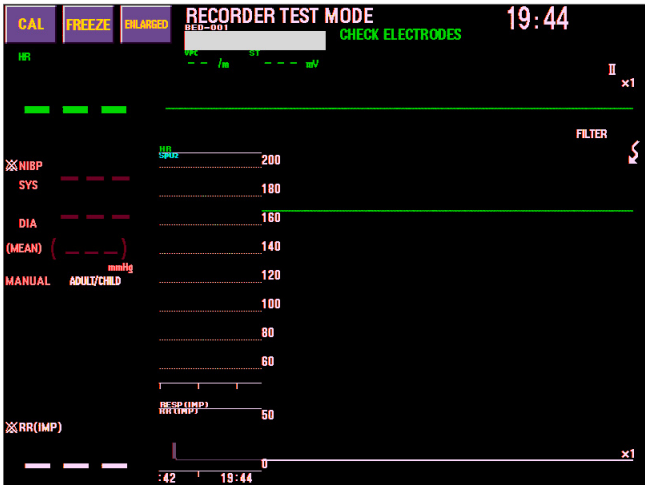
Recorder and Control Block Checks

This check program checks the thermal array recorder and recorder control block (recorder CPU peripherals) without communication with the host CPU. Therefore, this check is independent from the manual check menu.

This check allows you to inspect the quality of print, paper speed and feed, etc.

Procedure to start and exit the Recorder and Control Block Check Program

1. To start the check program, press and hold the record key on the recorder module and NIBP INTERVAL key until the monitoring screen appears when you turn on the power. The SELF-TEST-PRO No.1 check program is ready for the execution.



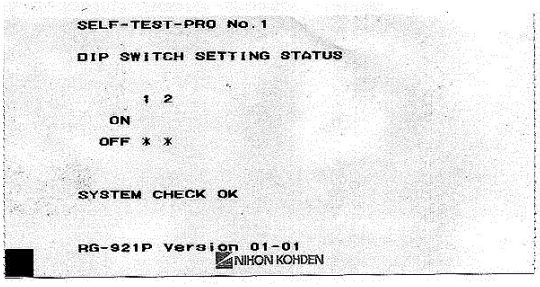
2. To select one of the three check programs for the recorder and control block checks, press the record key. Each time the record key is pressed, the check program changes as follows:
   SELF-TEST-PRO No. 1 → SELF-TEST-PRO No. 2 → SELF-TEST-PRO No. 3 → SELF-TEST-PRO No. 1

3. To start the selected check program, press the NIBP INTERVAL key.

4. To exit these checks, turn off the instrument.

SELF-TEST-PRO No.1

This check program checks the peripheral circuits of the recorder CPU, e.g. ROM, RAM and DIP switch setting status. The check result and recorder software version number are recorded on the paper as shown below approx. 30 seconds after the NIBP INTERVAL key is pressed. The recording starts soon after the black square on the paper is detected.



If an error is found, one of the following error codes appears on the paper.

Error Code	Description	Action
ROM	The ROM on the REC MAIN board is faulty.	Replace the REC MAIN board with a new one.
RAM	The RAM on the REC MAIN board is faulty.	Replace the REC MAIN board with a new one.
A/D	The common memory in the RACOON (ASIC) on the REC MAIN board is faulty.	Replace the REC MAIN board with a new one.

To move to the SELF-TEST-PRO No.2, press the record key.

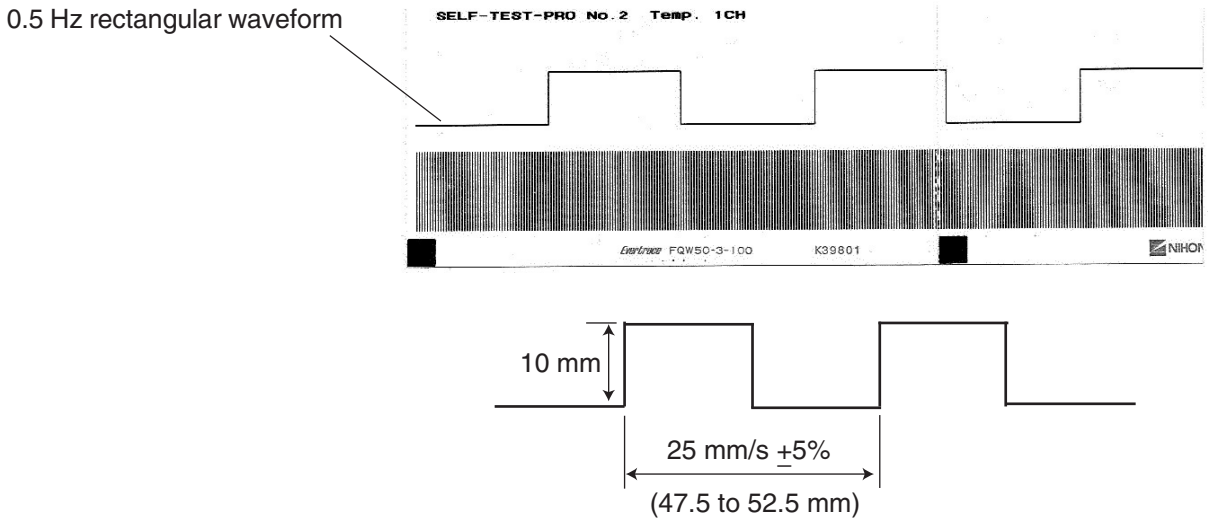
SELF-TEST-PRO No.2

This check program checks the paper speed, slip and snaking. A 0.5 Hz rectangular waveform and bar graph are recorded on the paper at 25 mm/s paper speed by pressing the NIBP INTERVAL key.

To stop the recording, press the NIBP INTERVAL key again.

To move to the SELF-TEST-PRO No. 3, press the record key.

25 mm/sec



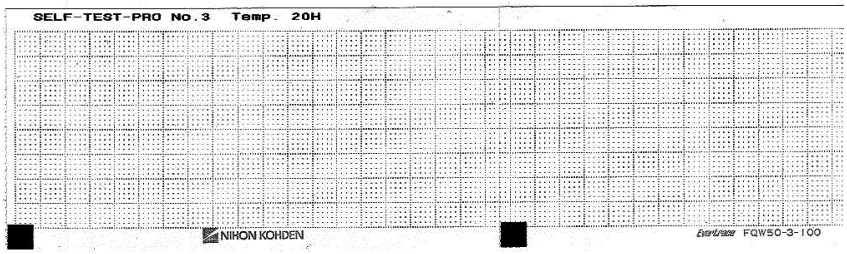
SELF-TEST-PRO No.3

This check program checks the recording quality. There are the following three recording patterns for scale, character and thermal array head checks.
The recording pattern changes automatically after the NIBP INTERVAL key is pressed for the recording start. The recording starts soon after the black square on the paper is detected.

To stop the recording, press the NIBP INTERVAL key again.

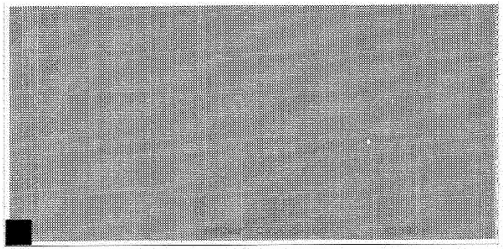
- Scale Check: Checks the circuit related to the scale recording in the recorder control block on the REC MAIN board. If the recording has something wrong, the REC MAIN board will be faulty.
- Character Check: Checks the circuit related to the character recording in the recorder control block on the REC MAIN board. If the recording has something wrong, the REC MAIN board will be faulty.
- Thermal Array Head Check: Checks the thermal array head condition and RAM for the storage of the data for the heat elements of the head. If there is a dot missing, faint dot or dark and faint dots mixed on the paper, check that the thermal array head is firmly attached and is not dirty. Replace the thermal array head with a new one if the head is cleaned but the problem still occurs. If the recording pattern has something wrong, the REC MAIN board will be faulty.

Scale Check



Character Check

Thermal Array Head Check



Calibration of Touch Screen

When you replace the touch screen or MAIN board with a new one, the touch screen must be calibrated. Or, depending on the setting position, the effective point may slightly shift due to viewing angle. In that case, re-calibrate after the instrument is set up.

Procedure to Start the Calibration of TOUCH PANEL

1. To start the calibration of the TOUCH PANEL, call up the DIAGNOSTIC CHECK screen.

2. Press the MENU key in this mode to display the TOUCH PANEL CALIBRATION screen.

3. A target mark will be displayed from upper left corner to lower right corner (total of 9 points). Touch the center of the target mark for more than 2 seconds until it moves to the next location.

4. After the calibration, you can confirm the recognized position. Touch anywhere on the screen and the target mark tracks your touching position.

5. To return to the DIAGNOSTIC CHECK screen, press the HOME key.

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Section 4 Board/Unit Description

MAIN Board 4.1
Analog Board 4.5
ECG/RESP Block 4.5
SpO_2 and MP Blocks 4.6
SpO_2 Block 4.6
MP Block 4.7
IBP Board 4.8
NIBP Board 4.9
Power Supply Block 4.10
LCD Unit 4.11
Recorder Module (Option) 4.12
REC MAIN Board 4.12
Recorder Unit 4.13
Interface (Option, QI-231P) 4.14
ECG, QRS Synch or Alarm Trigger Signal Output Block 4.15
Serial Data Communication Relay Block 4.15
RGB Relay Block 4.15
Interface (Option, QI-236P) 4.16
ECG and QRS Synch Trigger Signal Output Block 4.17
RGB Relay Block 4.17

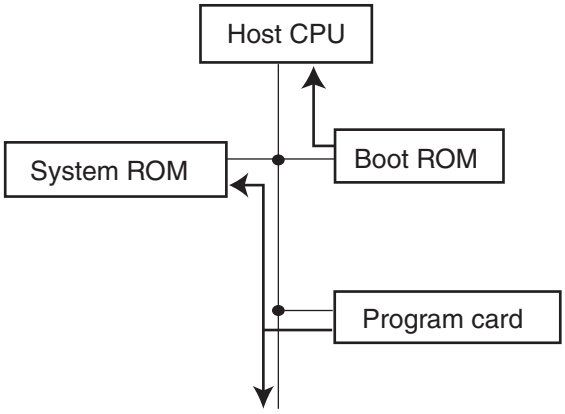
MAIN Board

The MAIN board consists of system control block, display control block, DPU block and power control block.

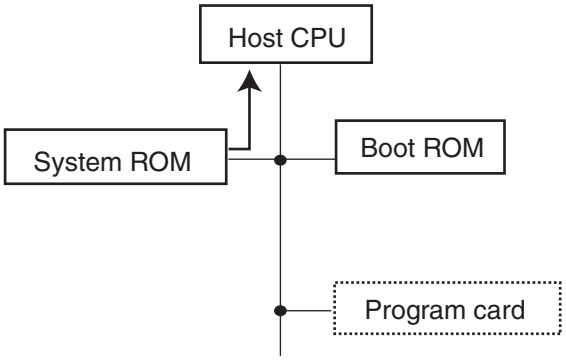
The system control block has the host CPU which controls the peripherals to receive the operation key status and display the waveforms and numeric data. The program is stored in the 2 MB system ROM (flash EEPROM) for host CPU, 128 KB Boot ROM in the system control block and 1 MB system ROM (flash EEPROM) for CPU on the REC MAIN board of the optional recorder module.

When the instrument is turned on, the host CPU executes the program in the Boot ROM. According to the program, the host CPU checks if the program card is inserted into the slot on the MAIN board. When the host CPU recognizes that the correct program card is inserted, the host CPU writes the program from the card to each system ROM. This is called Boot. Therefore, this Boot system allows you to upgrade the instrument without opening it. On the other hand, when the program card is not inserted into the slot, the host CPU switches from the Boot ROM to the system ROM on the MAIN board and executes the system program.

<When the program card is inserted>



<When the program card is not inserted>



a) System control block

The system control block consists of the host CPU, Boot ROM, system ROM, system RAM, backup RAM, real-time clock, PCMCIA card interface, touch screen controller, audio circuit and main gate array.

An MC68SEC000 is used as the host CPU. The clock frequency is 20 MHz. The host CPU controls the dedicated gate array, ASIC (Application Specific Integrated Circuit) ACORN, which controls the hard keys, touch screen, alarm indicator, QRS synchronous sound, alarm sound, real time clock, PCMCIA card interface, DPU communication and RS-232C communication.

The large capacity capacitor (Super capacitor) allows the 1 MB system RAM (SRAM) to back up the trendgraph, vital sign list, arrhythmia recall, monitoring conditions for each parameter and alarm settings for 30 minutes or more after the power is turned off. When the instrument is turned on after more than 30 minutes power off is past, the host CPU regards the backup data as damaged and initializes them if the Super capacitor is discharged too much to back up the various data.

The 32 KB backup RAM (non-volatile memory) permanently keeps the storage of the system setup conditions and alarm master settings after the power is turned off.

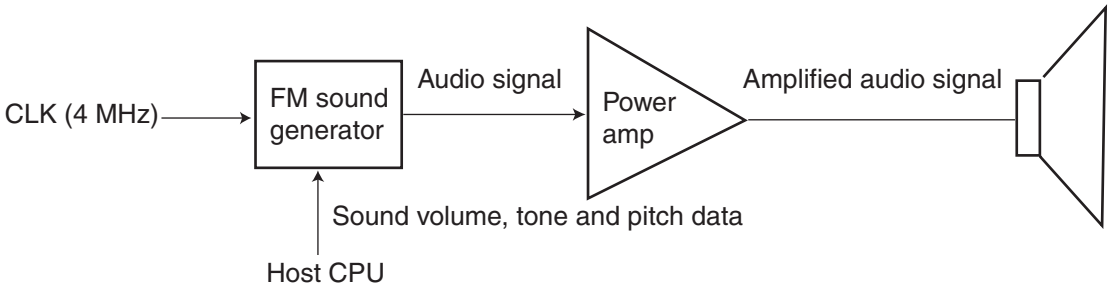
The lithium battery allows the real-time clock IC to update the date and time while the power is turned off. The lifetime of the lithium battery is approx. 6 years or more.

The PCMCIA card interface selects the bank at every 512 KB and can select the attribute memory or common memory from the PCMCIA card.

The host CPU periodically reads the status of all the hard keys on the instrument through the ACORN and executes the process according to the key status.

The touch screen is controlled by a dedicated microcontroller. When you touch a point on the screen, the microcontroller sends the touch position data to the host CPU through the ACORN with serial data communication.

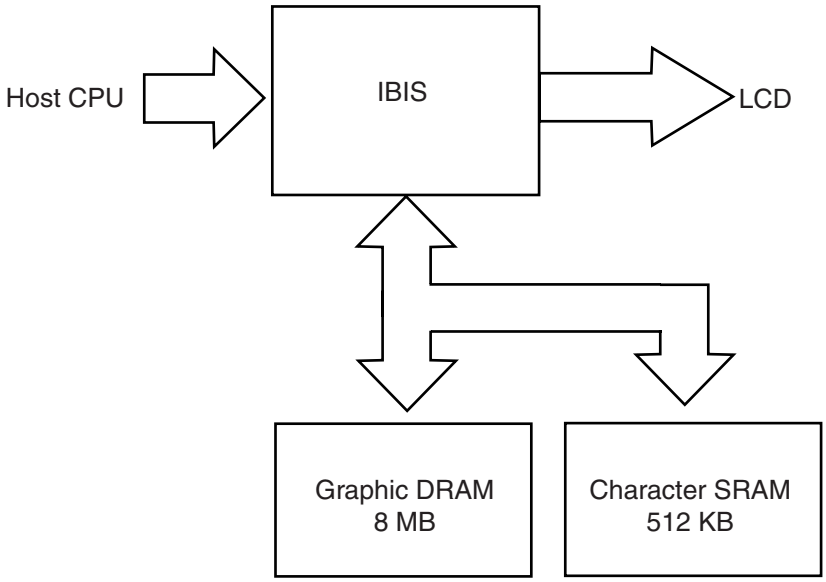
The audio circuit uses an FM sound generator (sound source IC) so that the QRS sound, alarm sound and key sound are generated at the same time. The sound volume control data as well as the tone and pitch data is written to the FM sound generator by the host CPU. The audio output signal from the FM sound generator is amplified by the audio power amplifier so that the speaker sounds.



b) Display control block

The display control block consists of the dedicated graphic ASIC IBIS for entire display control, 8 MB DRAM for display of waveform and graphic data, 512 KB high-speed SRAM for display of alphanumeric data and display interfaces for the LCD and an external RGB monitor.

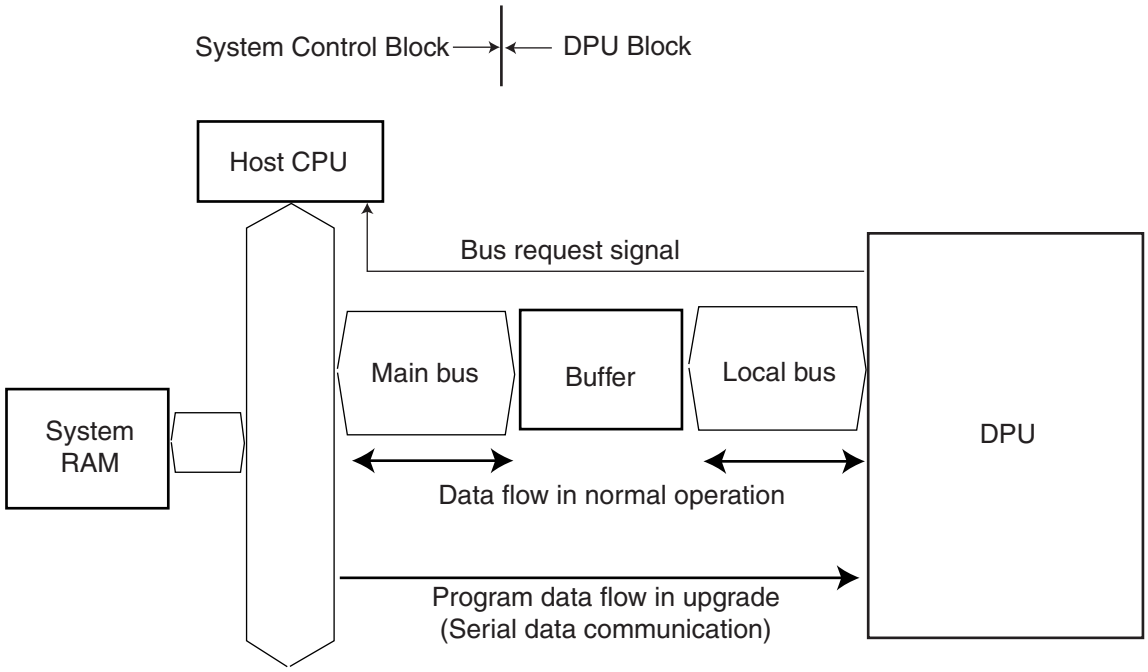
When the IBIS receives a display control command from the host CPU, the IBIS accesses these memories to get the display data and arranges the display data for RGB outputs. There are two RGB outputs. One is RGB output for the LCD. The other one is RGB output for a locally available RGB monitor.



c) DPU block

The DPU block has the DPU (H8S/2633 microcontroller) which works with 20 MHz clock. The DPU (Data Processing Unit) communicates with the floating amplifiers and ZB-900P transmitter interface on the Analog board and with the NIBP board. The DPU acquires the various data from these communications and processes the data to communicate with the host CPU. The DPU periodically writes the processed data into the system RAM on the main bus so that the data communication between the DPU and host CPU is done through the system RAM.

There are 256 KB flash EEPROM and 16 KB SRAM in the DPU. When the software is upgraded, the host CPU replaces the current program in the flash EEPROM with the new one in serial data communication.



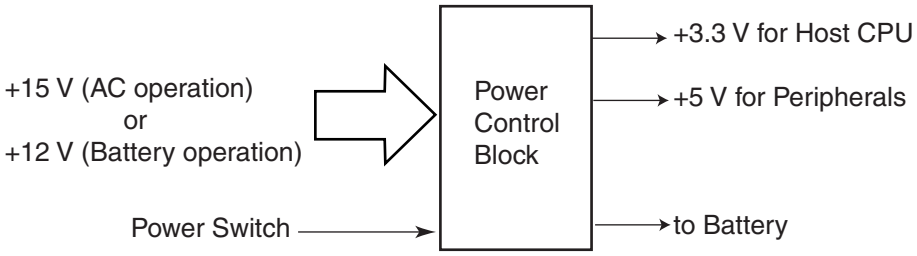
d) Power control block

The power control block consists of the power supply microcontroller, DC to DC converters, buzzer and its driver and battery interface.

+15 V from the power supply unit or +12 V from the rechargeable battery is converted to +3.3 V and +5 V supply voltages by the DC to DC converters and power supply microcontroller.

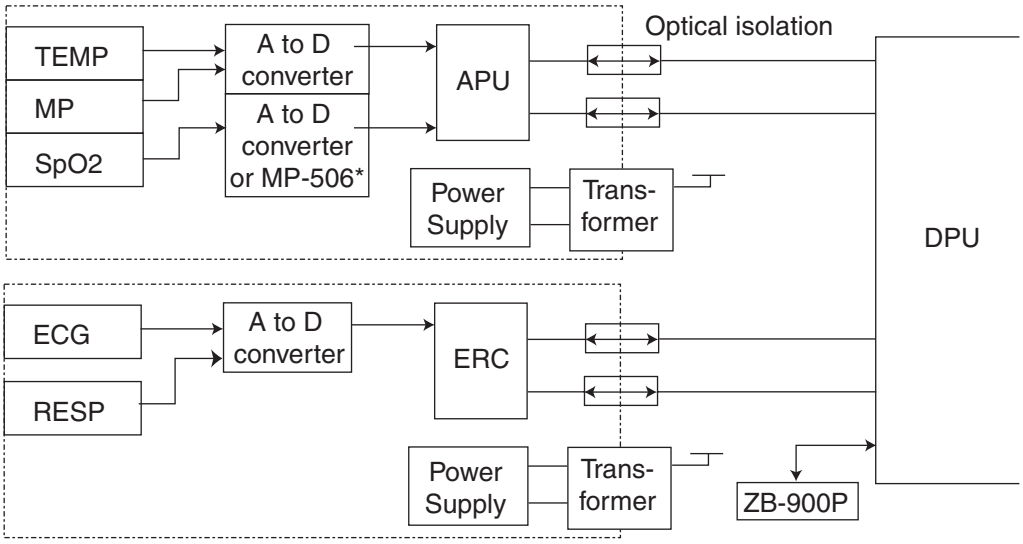
When the line voltage is supplied to the instrument and the battery is inserted into the instrument, the power supply microcontroller charges the battery with approx. 370 mA (normal charge) for 16 hours (maximum). After the normal charging, the controller uses trickle charging to charges the battery with approx. 370 mA for 1.2 seconds at interval of 1 minute so that the fully charged battery condition is maintained.

If the normal or trickle charging is interrupted for five hours or less by power failure or disconnection of the power cord and the battery is not removed from the instrument, the controller memorizes how many hours the battery is charged before the interruption. After it is removed, the controller charges the battery under the memorized condition to protect the battery against excessive charge.



Analog Board

The Analog board consists of the ECG/RESP block, SpO_2 block, MP block and ZB-900P interface block. The ECG/RESP block, SpO_2 block and MP block are electrically isolated from the ground, so these blocks are in the floating area. The ZB-900P interface block is not electrically isolated from the ground so this block is in the non-floating area. The vital sign input signals are digitized with the A to D converters in the floating area as shown below. Especially, the process such as calculation for the SpO_2 data is done in the floating area and the SpO_2 data goes to the DPU on the MAIN board through the non-floating area.



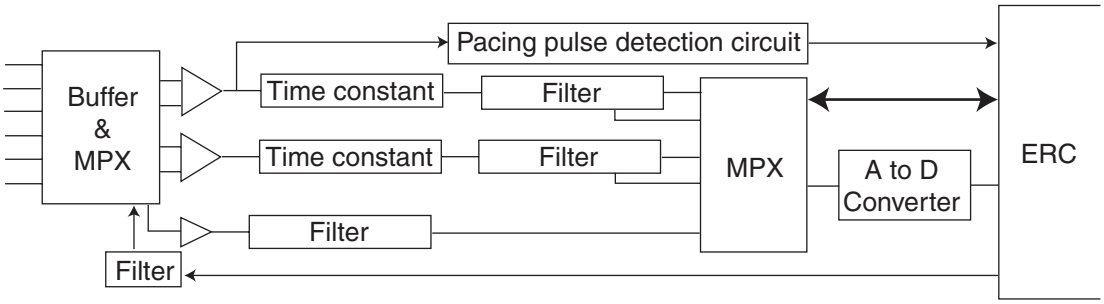
* BSM-2304A/2354A use MP-506 Nellcor SpO_2 unit.

ECG/RESP Block

There is a dedicated microcontroller ERC (PIC16C63A) in the ECG/RESP block. This ERC (ECG/Resp Controller) communicates with the DPU and controls the A to D converter and selects the time constant and filter settings.

The ECG circuit has two individual amplifiers, time constant setting circuits and hum and low pass filter setting circuits so that two lead ECG waveforms selected from the eight ECG leads (I, II, III, aVR, aVL, aVF and 2 chest leads) are simultaneously displayed on the screen when 6-wire type disposable electrode lead is used.

The impedance method respiration circuit also is in this block. The constant current generator (exciter) and impedance change detection circuits are included. The voltage proportional to the impedance change (including the electrode contact impedance) between the two electrodes for the pickup is multiplexed and digitized in this block.



SpO_2 and MP Blocks

In these blocks including the temperature block, there is a dedicated microcontroller APU (H8S/2633) which works with 20 MHz clock. The APU (Analog-block Processing Unit) communicates with the DPU and controls the respective A to D converters and executes each data processing for SpO_2, temperature and the other vital sign such as blood pressure connected to the multi-parameter socket.

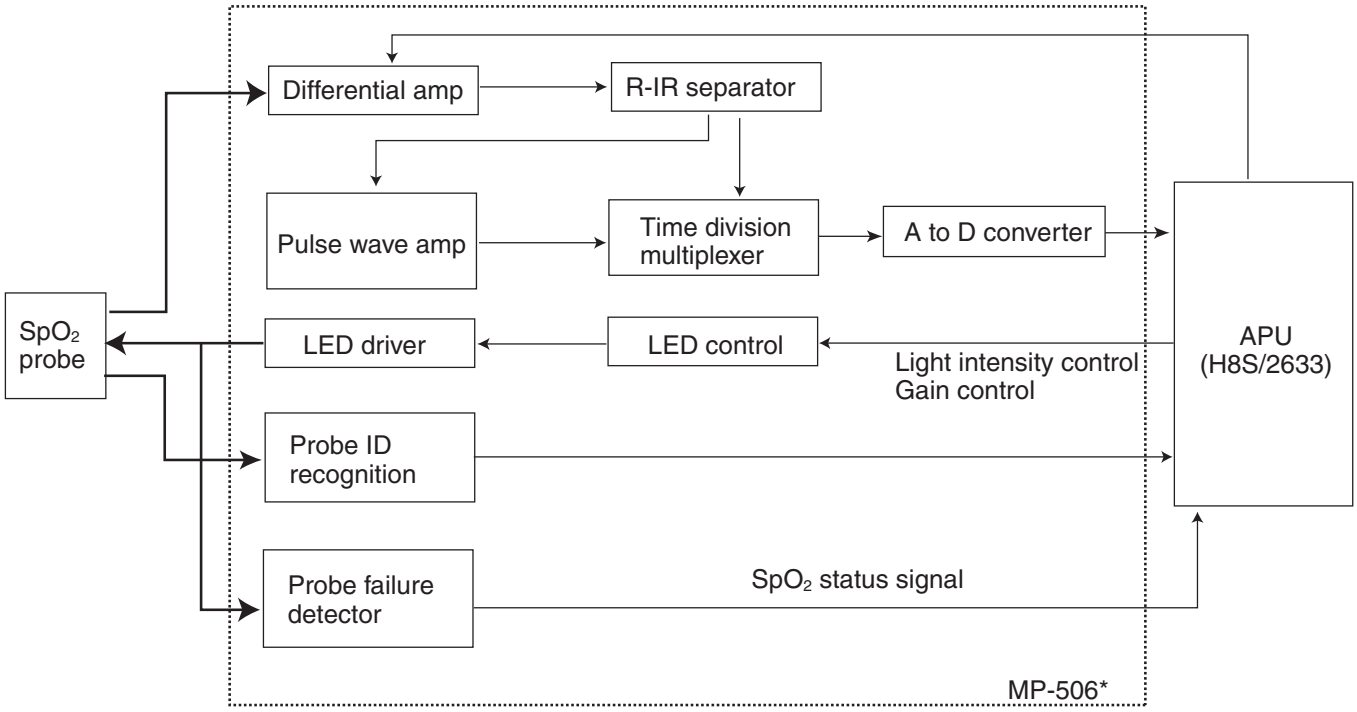
There is a flash EEPROM in the APU. When the software is upgraded, the host CPU replaces the current program in the flash EEPROM with the new one.

SpO_2 Block

This block has the following circuits.

- Differential amplifier: Amplifies the electrical signals detected by the photodiode when the red LED and infrared LED in the SpO_2 probe alternatively transmits the lights to the subject.
- R-IR separator: Separates the electrical signals caused by the red LED and infrared LED transmissions to the subject.
- Pulse wave amplifier: Amplifies the red LED and infrared LED pulse waves.
- Multiplexer: Multiplexes the analog signals such as pulse waves.
- LED drive current control: Controls the drive currents for the red LED and infrared LED.
- Probe ID recognition: Detects the probe ID and sends the status data to the APU.
- Probe failure detector: Detects the short circuit in the probe and sends the status data to the APU.

The APU controls the SpO_2 block totally and calculates the SpO_2 data from the various data digitized by the A to D converter (in BSM-2301A/C/K, BSM-2303C/K, BSM-2351A/C/K and BSM-2353C/K) or receives the SpO_2 data from the MP-506 Nellcor SpO_2 unit (in BSM-2304A/2354A).

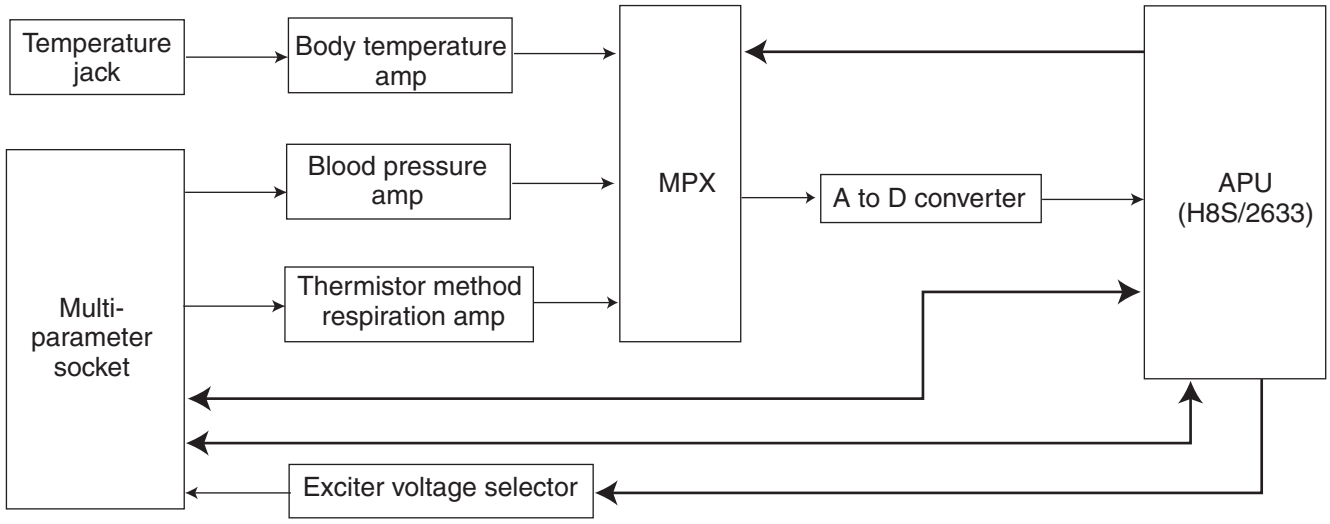


* In BSM-2304A/2354A, the MP-506 Nellcor SpO_2 unit replaces the block surrounded by a dotted border.

MP Block

The MP block consists of the blood pressure amplifier circuit, thermistor method respiration circuit and temperature block. The APU recognizes which sensor/ transducer is connected to the multi-parameter socket and selects the exciter voltage. When the CO_2 sensor is connected to the socket, the APU communicates with the CO_2 sensor

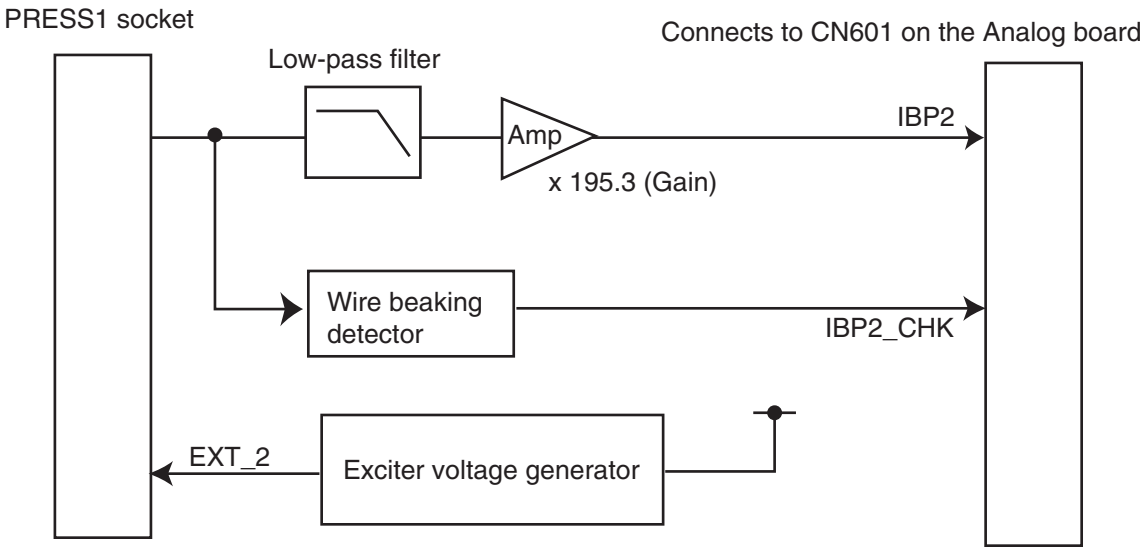
The APU receives the digital data from the A to D converter every 2 ms and sends the data to the DPU.



IBP Board

BSM-2301 and BSM-2351 have no IBP Board.

The IBP board has the input block for invasive blood pressure measurement. This board consists of the exciter voltage generator and input amplifier. The amplified blood pressure signal is sent to the multiplexer and A to D converter of the MP block in the floating area on the Analog board. The digitized data of the blood pressure signal is sent to the microcontroller APU on the Analog board.



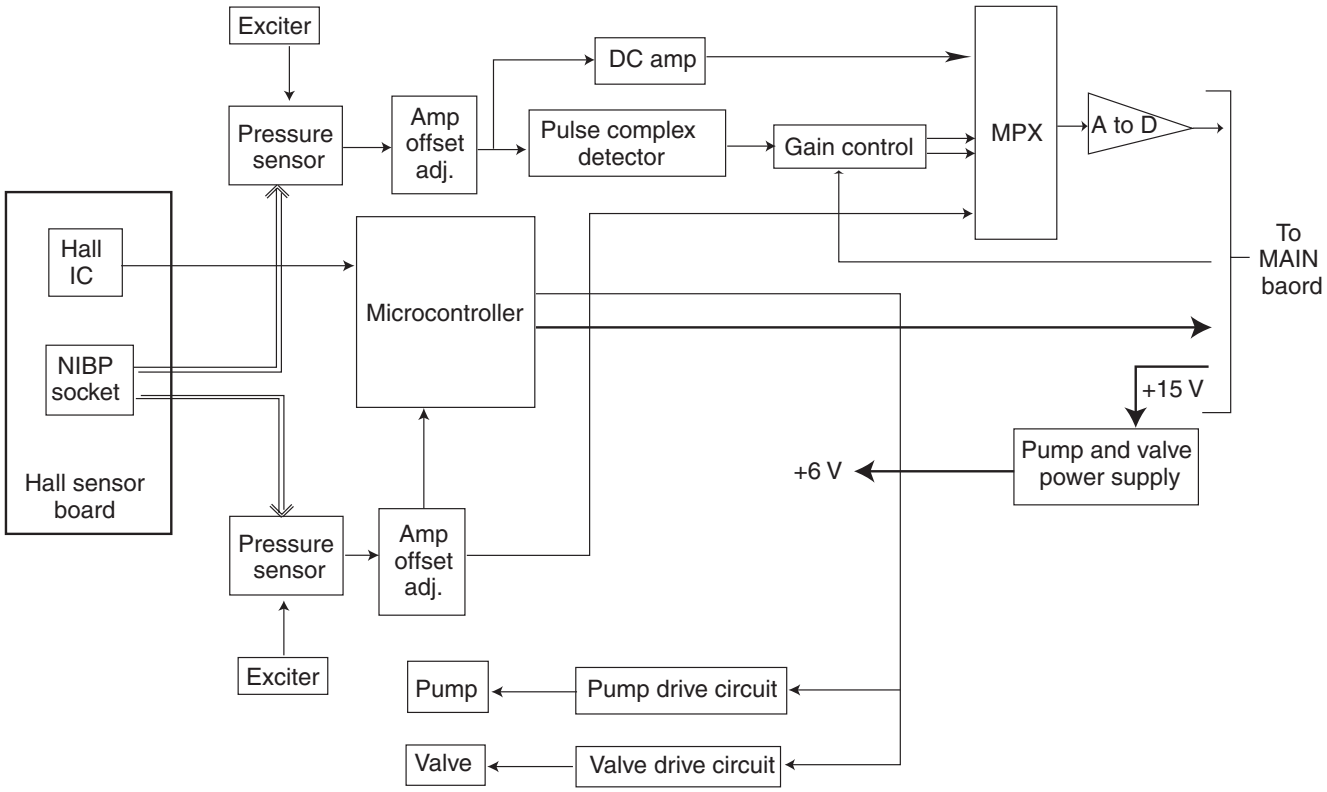
NIBP Board

The NIBP board has the pressure sensor for NIBP measurement to detect the cuff pressure and convert it to an electrical signal. There is no adjustment which can be done locally.

A microcontroller for safety control, pressure sensor for safety, solenoid valve, pump and power supply cut-off circuit for the valve and pump are on the NIBP board. The cuff pressure is individually monitored by this safety circuit and the DPU on the MAIN board. If a wrong operation such as excessive cuff inflation caused by the faulty MAIN board or the faulty measurement circuit on the NIBP board occurs, the safety circuit on the NIBP board provides the multi safety functions so that the patient is protected from the wrong operation.

If the microcontroller works for the safety, the drive voltage is not supplied to the pump and valve for 30 sec. This prevents the cuff from inflating during this period.

Since the measurement data from the measurement circuit and safety circuit are compared and the operation of the safety circuit is always monitored, the “Safety Circuit Error” status message immediately appears on the screen if the NIBP measurement has something wrong.



Power Supply Block

The power supply block consists of the power supply unit (+15 V DC output), rear chassis, fuse holder built-in type AC inlet socket, ground terminal and line frequency detection coil. Refer to Section 8 “REPLACEABLE PARTS LIST”.

This power supply unit same as in the BSM-1101/1102, BSM-4100 series and WEP-4204/4208 is used.

LCD Unit

8.4/10.4 inch TFT color LCD which has 800 dots × 600 dots (SVGA) is used as the display. This LCD unit can display maximum 512 colors. 12 colors can be assigned for waveforms and each vital sign parameter by the user.

Since the LCD unit is covered with a polarization filter which is weak against an impact and pressure, it requires your attention during service.

The LCD unit has two cold cathode tubes to backlight the LCD. The high voltage for the two tubes is supplied from the inverter board.

It takes approx. 50,000 hours (about 5 years and 9 months) for the brightness to decrease from maximum to half brightness (lifetime of the backlight) if the two tubes at the maximum brightness work in continuous operation. Therefore, the tube may need to be replaced after 50,000 hours of use.

Recorder Module (Option)

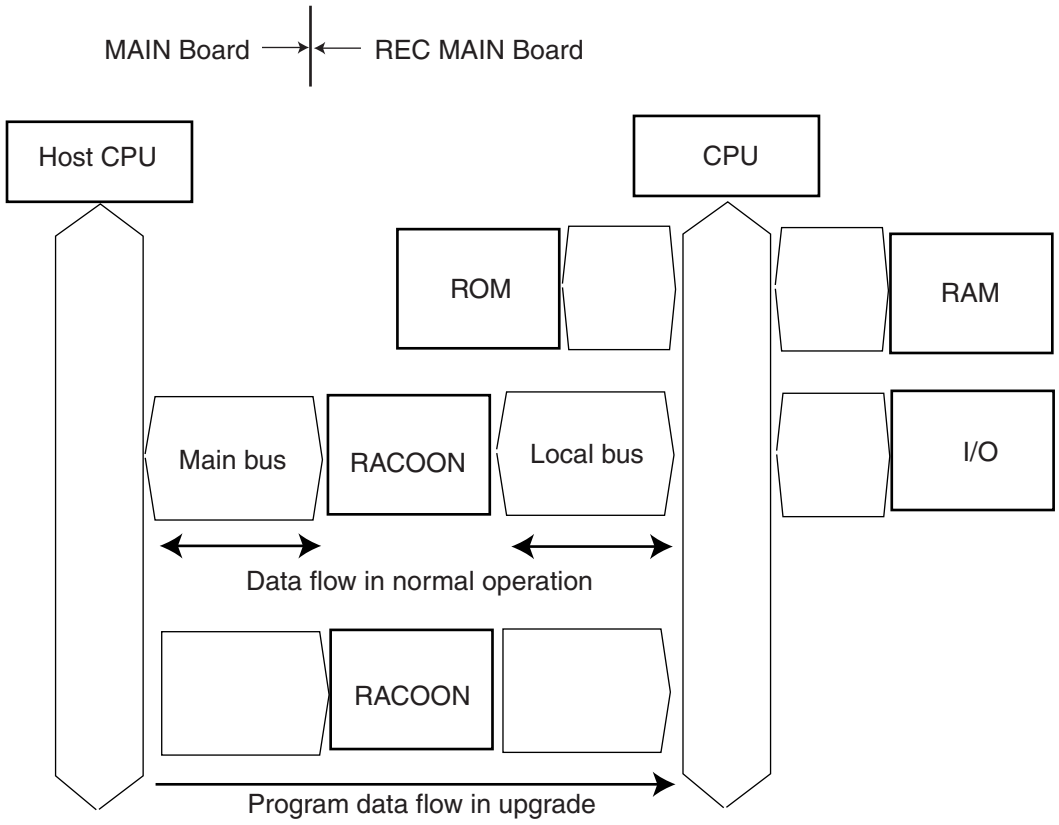
The recorder module has the REC MAIN board and recorder unit as shown below.

REC MAIN Board

The REC MAIN board has the CPU (20 MHz MC68SEC000), 1 MB system ROM for program storage, 512 KB system RAM for the CPU working area and a dedicated recorder control ASIC RACOON.

The CPU on this board communicates with the host CPU on the MAIN board through the RACOON. The RACOON controlled by the CPU on this board controls all the recording functions such as the paper drive motor control and thermal array head control.

When the instrument is upgraded, the bus on this board is directly connected to the main bus on the MAIN board and the 1 MB system ROM takes a part of the memory for the upgrade program. The host CPU replaces the previous program in the 1 MB system ROM with the new one.



Recorder Unit

The recorder unit consists of thermal array head, paper drive motor, gears, recorder chassis, sensor board (paper and mark detectors included) and sensor control board.

The RACOON (ASIC) on the REC MAIN board allows the recorder unit to record the 3 channel waveforms, vital sign list and trendgraph.

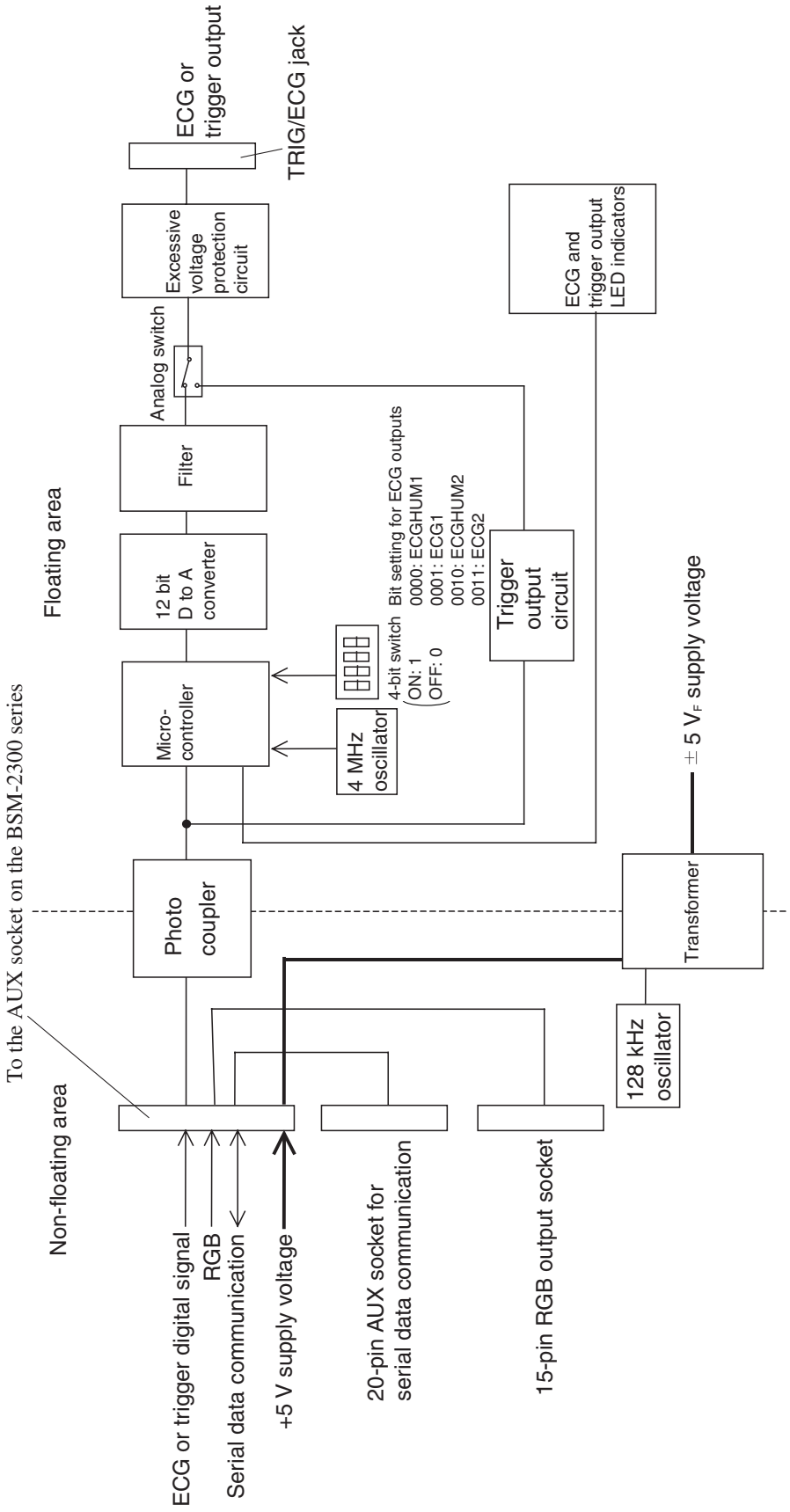
Since the thick membrane type thermal array head is used, it does not require the adjustment of the supply voltage to the head. The lifetime of the heating elements on the head is 100 million heating times.

A stepping pulse motor is used as the paper drive motor. The lifetime of the motor is approx. 3,000 hours continuous operation.

When the paper detector or mark detector (LED and phototransistor assembly) on the sensor board is replaced with a new one, the gain control VR on the sensor control board must be adjusted. See Section 7 “ADJUSTMENT”.

Interface (Option, QI-231P)

The interface has the IO ANALOG OUT board inside. This board consists of the following three blocks.



ECG, QRS Synch or Alarm Trigger Signal Output Block

Data of the ECG, QRS synch or alarm trigger signal from the AUX socket of the bedside monitor are sent to the floating area of the board through the photo coupler. In the floating area, the data are sent to the microcontroller (PIC16C63A) which communicates with the bedside monitor, selects the output signal with the analog switch, controls the D to A converter, selects the ECG1 or ECG2 with or without hum filter according to the 4-bit switch setting and lights the ECG or TRIG LED. When the ECGHUM1 is selected, the hum filtered ECG1 analog signal from the D to A converter goes to the output jack.

Serial Data Communication Relay Block

The current software does not support this communication.

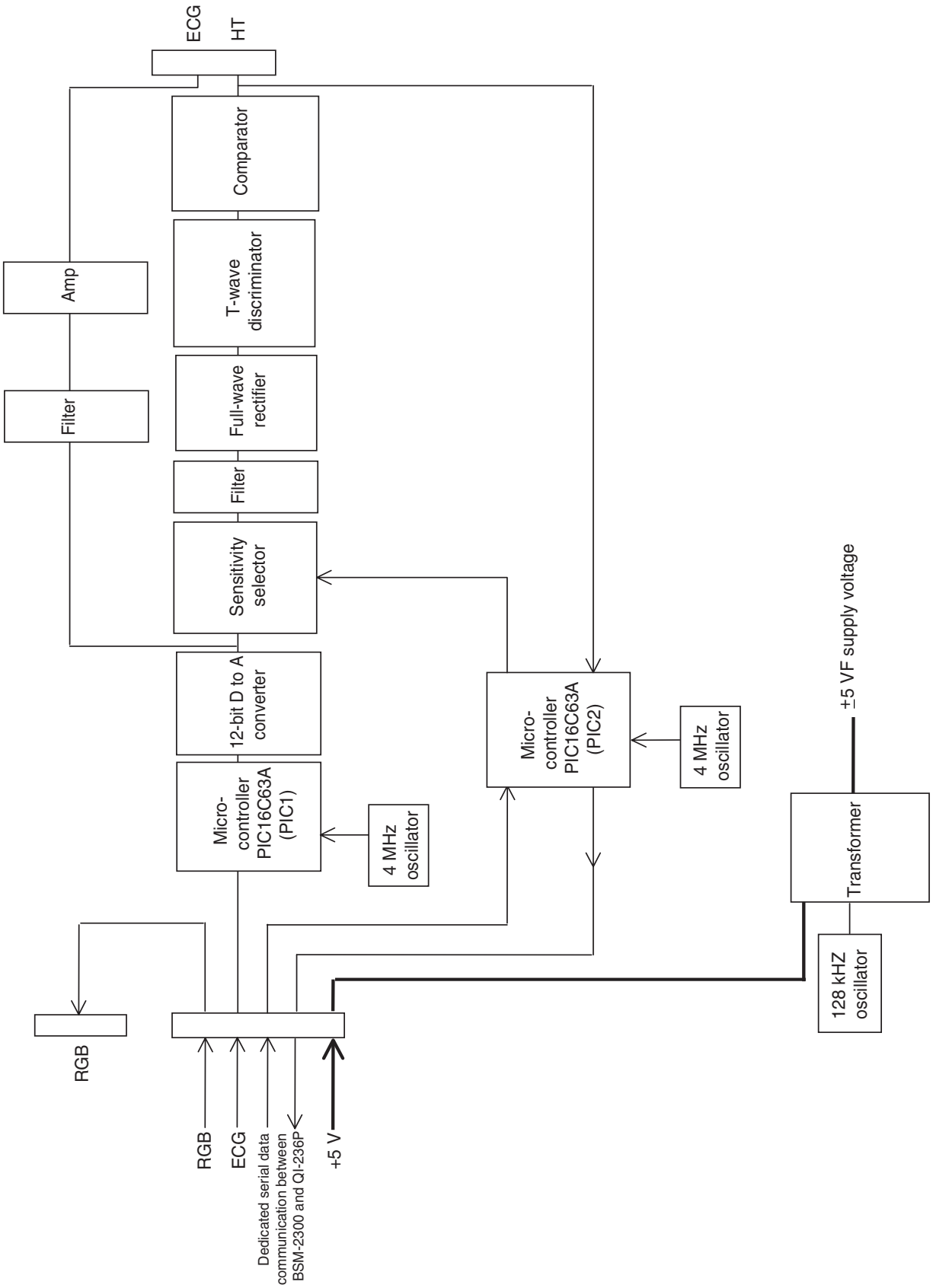
When an external device which has an RS232C port is connected to the RS232C socket on this board, the serial data will be communicated between the external device and bedside monitor through this board if the same communication protocol is used between the external device and bedside monitor.

RGB Relay Block

The RGB analog signals are sent to the RGB output socket on this board through the AUX socket of the bedside monitor.

Interface (Option, QI-236P)

The interface has the IO CT OUT board inside. This board consists of the following two blocks.



ECG and QRS Synch Trigger Signal Output Block

Data of the ECG signal from the AUX socket of the bedside monitor are sent to the microcontroller (PIC16C63A:PIC1) which controls the D to A converter. The data from the D to A converter goes to two circuits. One is the QRS detection circuit. This signal is output as the QRS synch trigger signal “HT”. The “HT” signal is sent to the microcontroller (PIC16C63A:PIC2) which communicates with the bedside monitor. The other is a filtered ECG analog signal which goes to the output connector as “ECG”.

RGB Relay Block

The RGB analog signals are sent to the RGB output socket on this board through the AUX socket of the bedside monitor.

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Section 5 Disassembly and Assembly

Removing the Chassis Block 5.1
Replacing the MAIN Board 5.6
Replacing the Analog Board 5.10
Replacing the NIBP Board 5.12
Replacing the IBP Board 5.14
Replacing the Inverter Board (BSM-2301/2303/2304) 5.15
Replacing the Inverter Board and Inverter IF Board (BSM-2351/2353/2354) 5.17
Replacing the LCD Unit (BSM-2301/2303/2304) 5.19
Replacing the LCD Unit (BSM-2351/2353/2354) 5.21
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Replacing the Backlight Lamp Unit (BSM-2301/2303/2304) 5.24
Replacing the Backlight Lamp (BSM-2351/2353/2354) 5.26
Replacing the Lithium Battery 5.28
Replacing the Battery Pack 5.29
    When the Recorder Module is Not Attached to the Instrument 5.29
    When the Recorder Module is Attached to the Instrument 5.31
Replacing the IO ANALOG OUT or IO CT OUT Board of the Optional Interface 5.33

Removing the Chassis Block

CAUTION

- **Turn off the instrument and disconnect the power cord from the instrument before beginning the disassembly procedure.**
- **Before placing the instrument on a table, if its surface is dirty, hard or rough, cover the table with a clean, soft and smooth material to avoid making the screen dirty and damaging the screen.**

1. Place the instrument face down on the table as shown below.

<When the recorder module is not attached to the instrument>

2-1a. Remove the 3 screws from the bottom of the instrument with a long Phillips screwdriver. Separate the battery box (enclosure) from the instrument and put the battery box close to the instrument because the battery cable is connected to the battery pack in the battery box.

2-1b. Disconnect the battery pack from the battery cable and remove the battery box from the instrument.

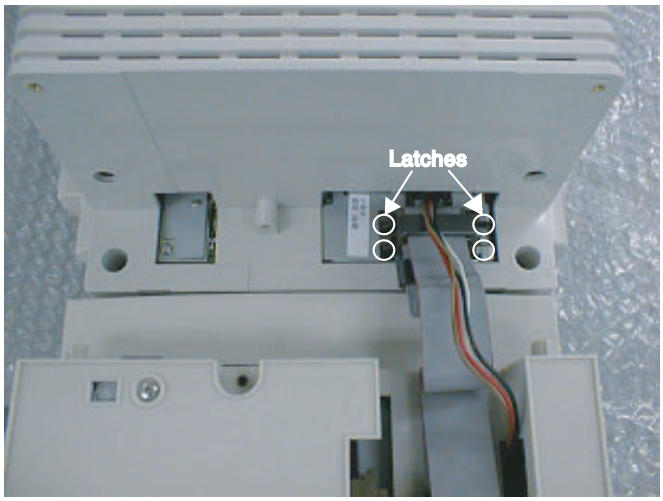
<When the recorder module is attached to the instrument>

2-2a. Remove the 3 screws from the bottom of the recorder module with a long Phillips screwdriver. Refer to the figure in step 2. Separate the recorder module from the instrument and put the recorder module close to the instrument because the battery cable and two flat cables are connected between the recorder module and instrument.

2-2b. Gently pull the battery cable until the connectors come out from the recorder module.

2-2c. Disconnect the battery cable from the battery pack of the recorder module.

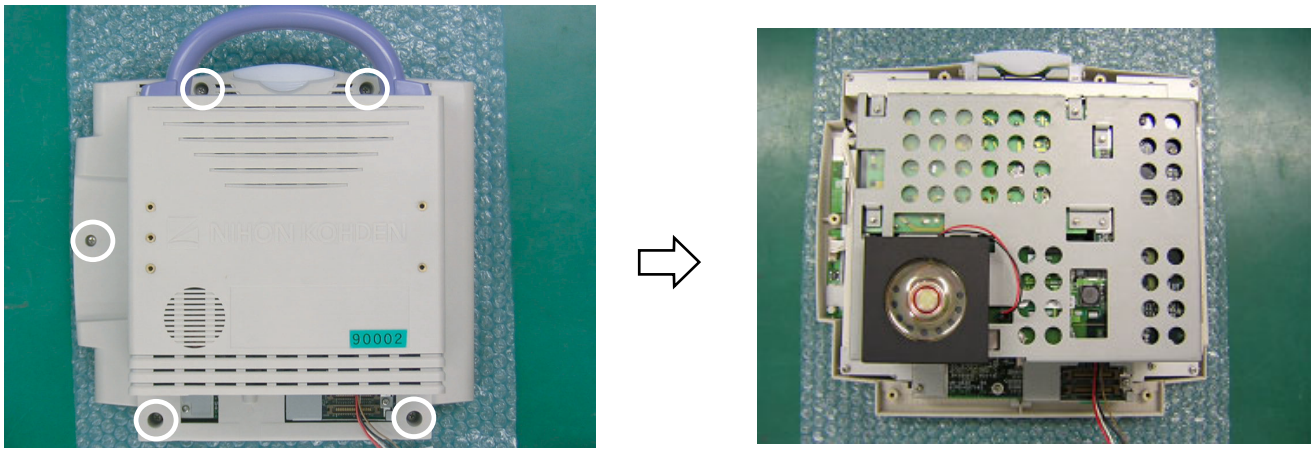
2-2d. Press the latches at both ends of the upper flat cable connector to release the lock and disconnect the upper flat cable from the instrument. Press the latches at both ends of the lower flat cable connector to release the lock and disconnect the lower flat cable from the instrument. Remove the recorder module from the instrument.



NOTE in Assembling the Instrument

When connecting the two flat cables to the instrument, check the direction of the connector and insert it into the socket of the instrument until the connector clicks. Check that the longer flat cable is connected to the upper socket of the instrument.

3. Remove the 5 screws from the rear enclosure and remove the rear enclosure from the instrument as shown below. The rear chassis appears.



NOTE in Assembling the Instrument

When attaching the rear enclosure to the instrument, be careful not to pinch or strain the internal wires or cables and tubes.

4. Remove the 2 screws from the left and right side panels and remove them from the chassis block.

<Right side>

<Left side>
BSM-2301 and BSM-2351 have no PRESS1 socket.
BSM-2304A and BSM-2354A have Nellcor SpO_2 socket instead of NK SpO_2 socket.

5. Disconnect the 4 cables as shown below.

CAUTION

- **To disconnect the touch screen cable (film cable), pull up the black flange of the socket on the MAIN board so that the cable is set free.**
- **Before disconnecting the touch screen cable (film cable), wear gloves to protect the film cable from fingerprints and any damage.**
- **When connecting the touch screen cable (film cable) to the socket, check that the flange is set to the original position after the cable is properly inserted into the socket.**

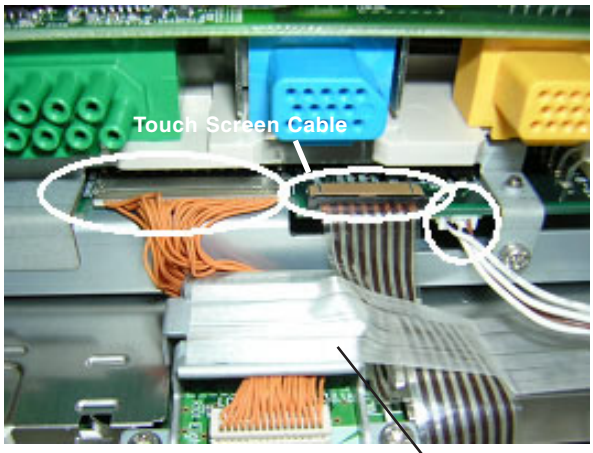
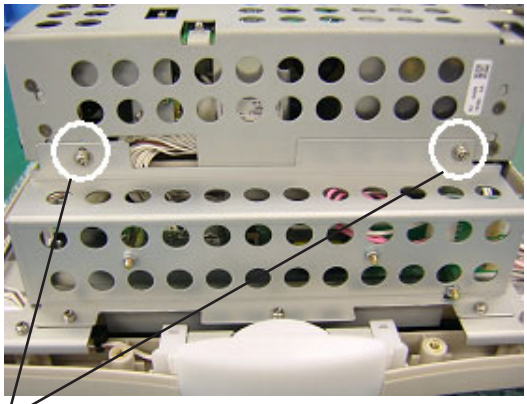


Photo shows BSM-2351/2353/2354

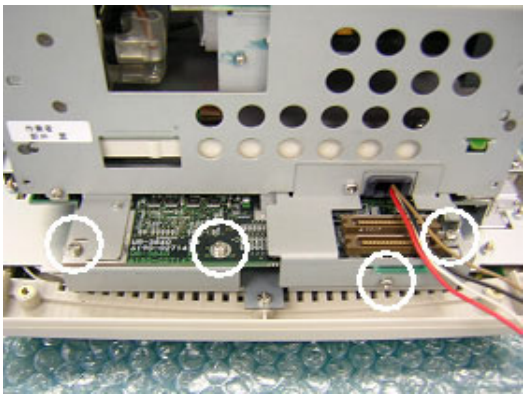
Filament tape

6. Remove the 10 screws from the chassis block as shown below.

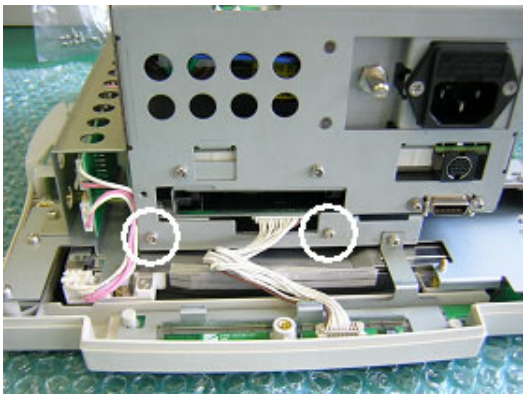


Screw with washer

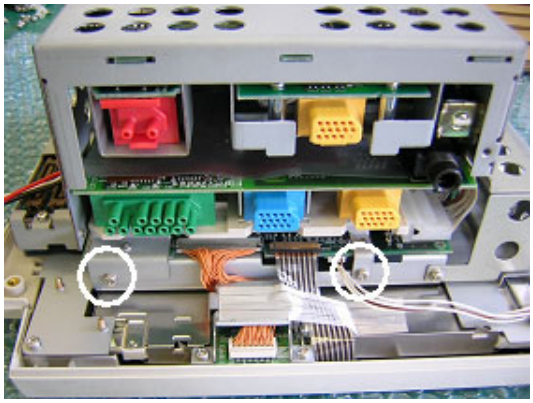
<Top side>



<Bottom side>

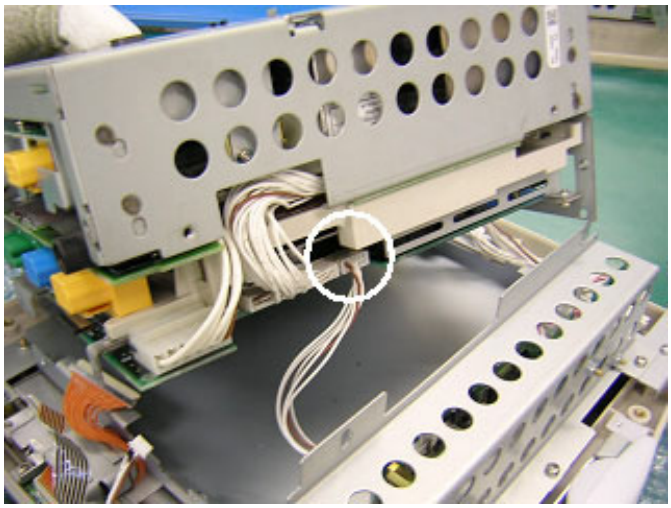


<Right side>



<Left side>

7. Slightly lift the chassis block and disconnect the inverter board cable from the chassis block.

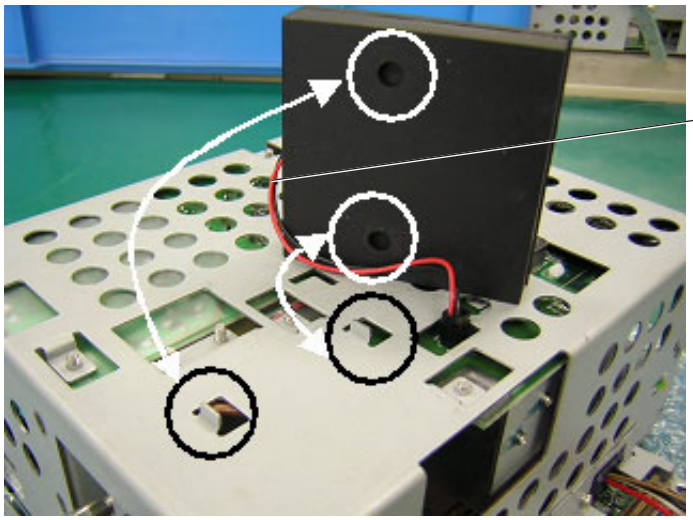


8. Separate the front enclosure from the chassis block.

9. Remove the speaker holder from the rear chassis by gradually swinging the speaker holder rightward and leftward.

NOTE in Assembling the Instrument

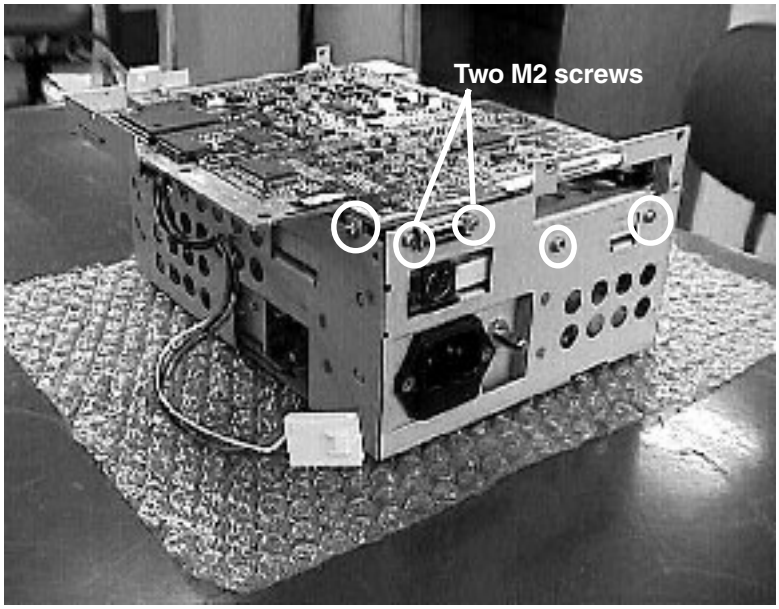
Check that the speaker wires come out at the top of the speaker holder.



Replacing the MAIN Board

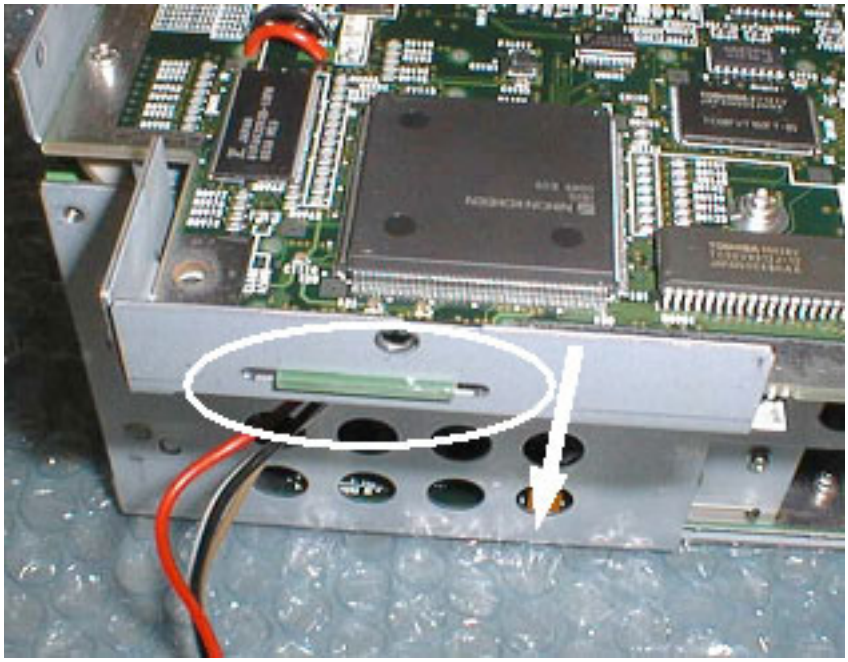
Perform the following procedure after the “Removing the chassis block” procedure.

1. Remove the 5 screws (two M2 screws included) which secure the MAIN board as shown below.

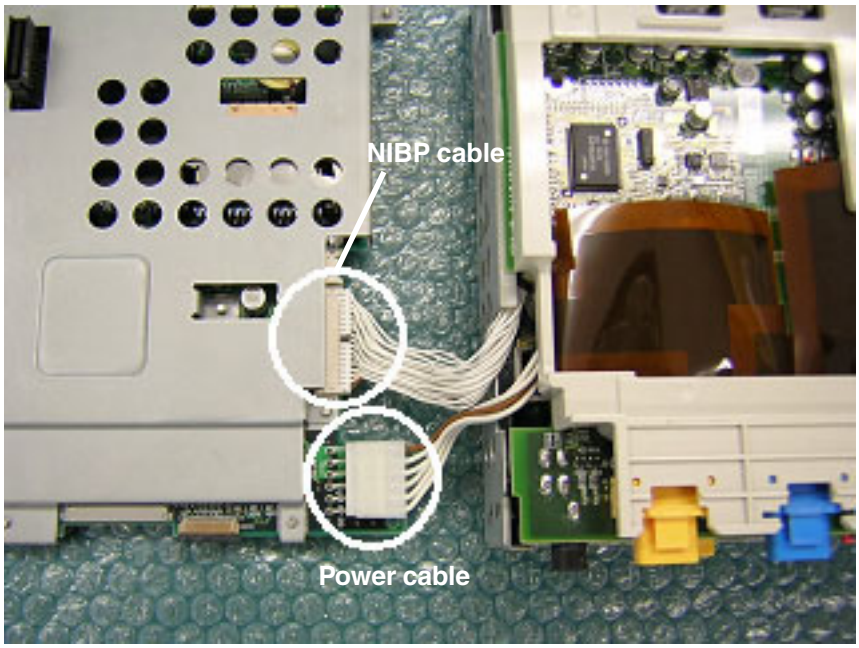


2. Slightly lift the MAIN board as shown below and separate the connector on the MAIN board from the connector on the Analog board.

3. Pull the MAIN board holder outward as shown below and pull the tab of the MAIN board upward to remove the tab from the slot.



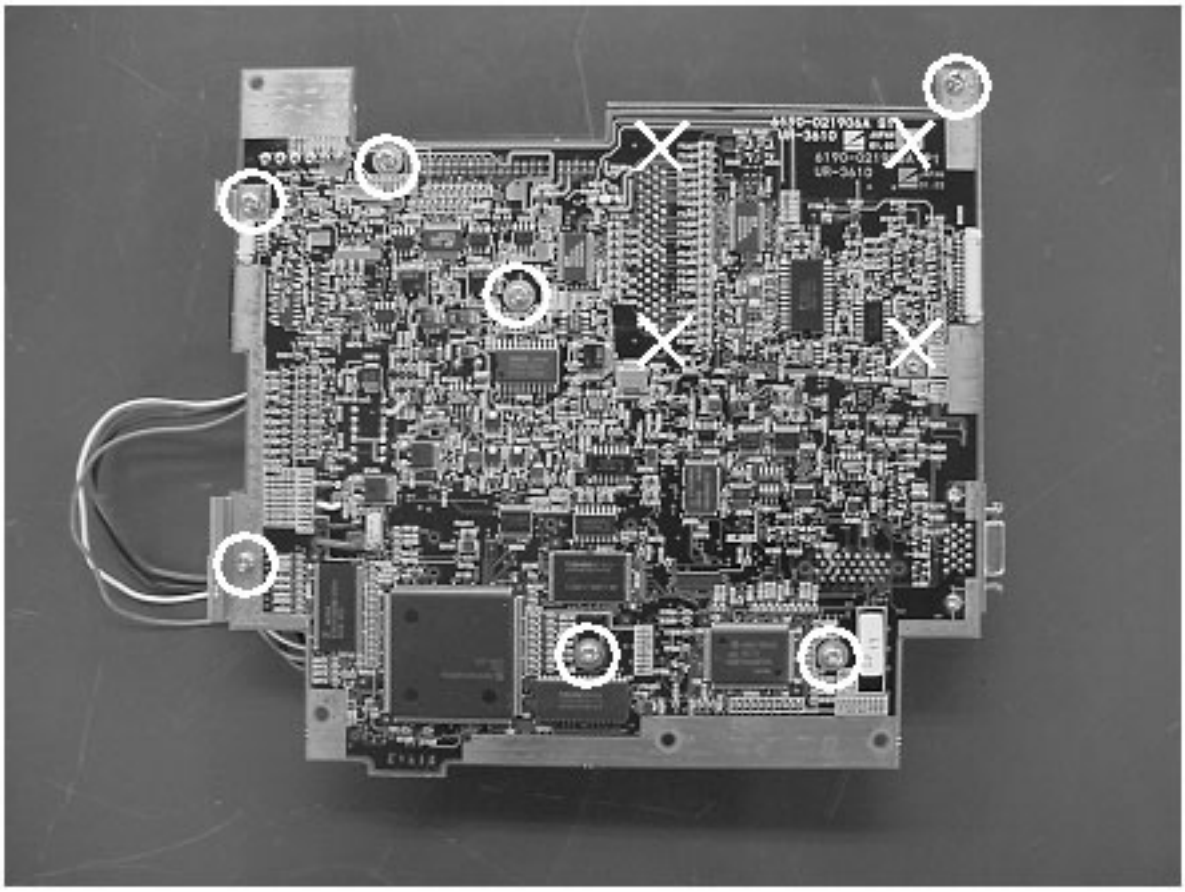
4. Put the MAIN board beside the chassis block and disconnect the power cable and NIBP cable from the MAIN board.



5. Remove the 7 screws (marked with circles in the following picture) from the MAIN board and remove the shield cover from the MAIN board.

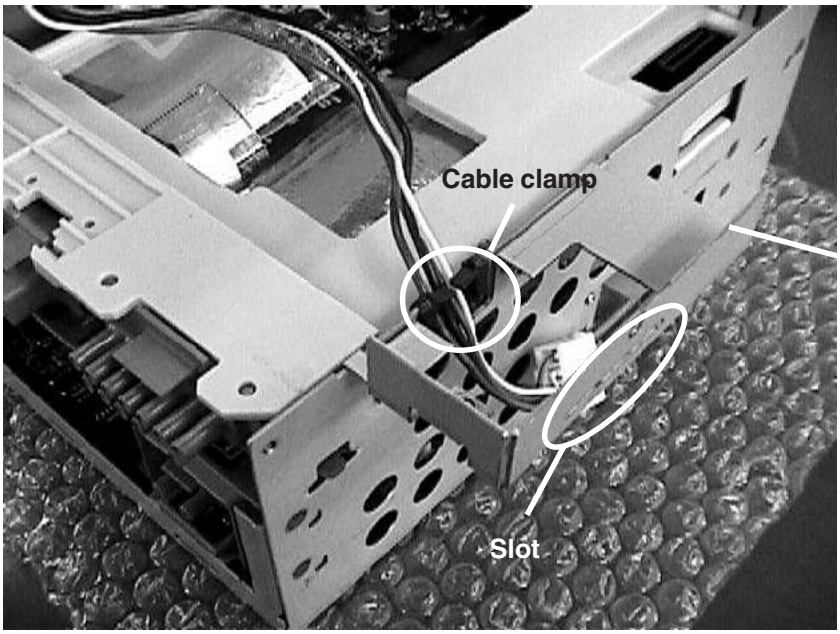
NOTE

Do not remove the 4 screws marked with X which secure the PCMCIA card slot socket.



CAUTION in Assembling the Instrument

- **Hold the battery cable with the cable clamp of the MAIN board holder and pass the battery cable through the MAIN board holder as shown below.**
- **Before fitting the MAIN board into the chassis block, insert the tab of the MAIN board into the slot of the MAIN board holder.**
- **To fit the MAIN board into the chassis block, align the connector on the MAIN board with the connector on the Analog board and press the MAIN board around the connector onto the Analog board. Check that the connection between the boards is complete.**



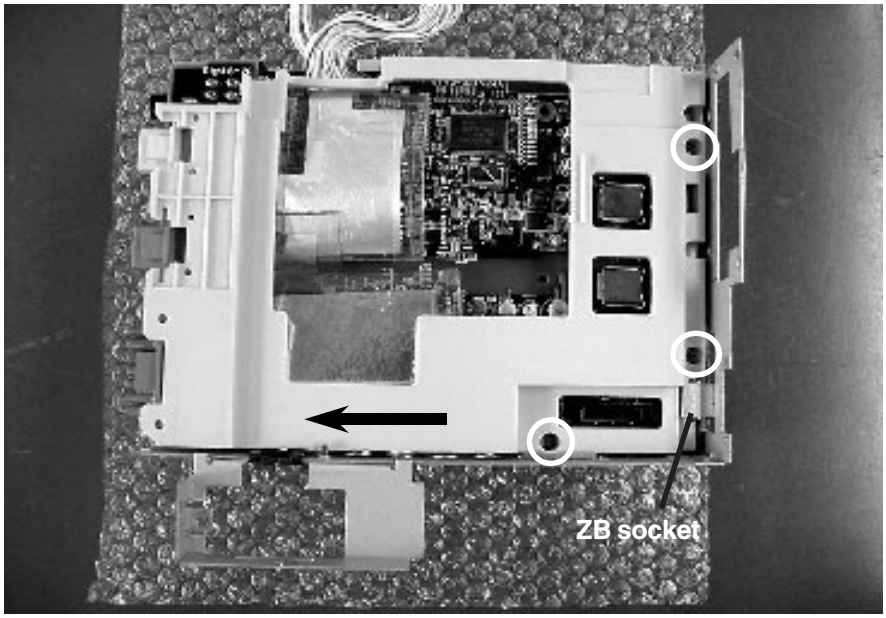
Replacing the Analog Board

Perform the following procedure after the “Replacing the MAIN Board” procedure step 4.

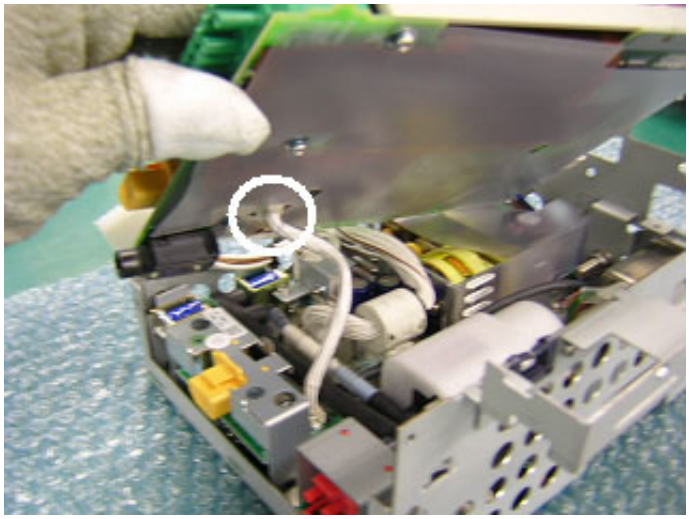
1. Remove the 3 screws (marked with circles in the following picture) which secure the Analog board to the chassis block.

NOTE

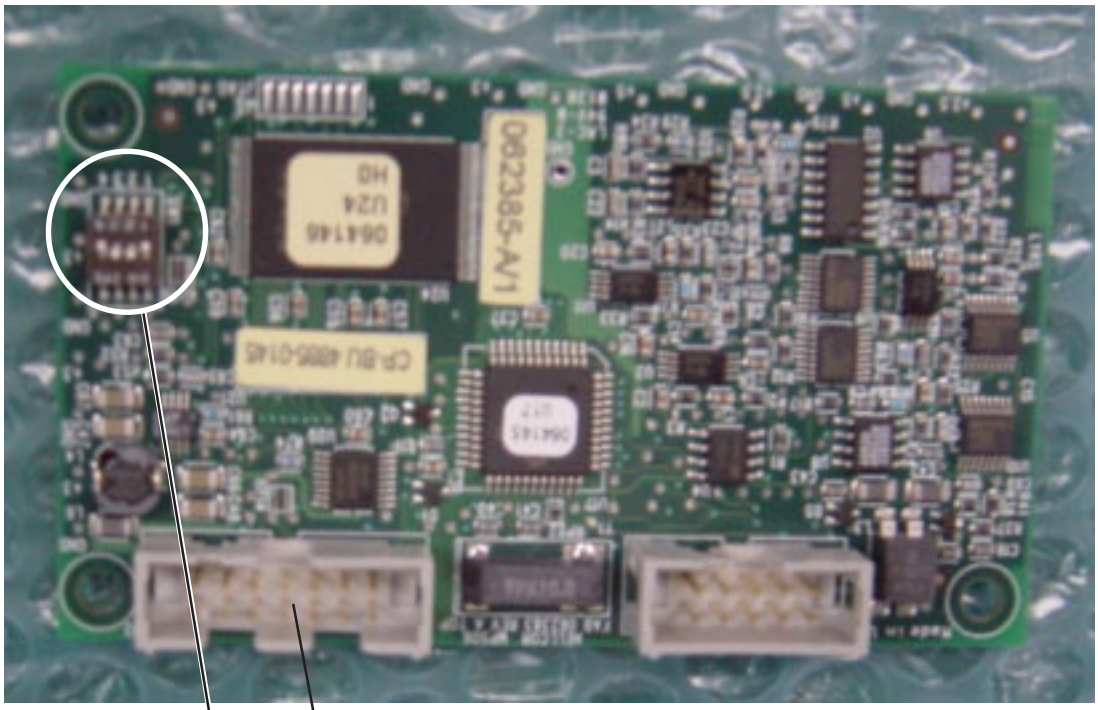
If the 3 screws are left in the holes, it may be difficult to slide the Analog board.



2. Slide the Analog board in the direction of the arrow in the picture below to avoid obstruction of the ZB socket and remove the Analog board from the chassis block.
   In case of BSM-2303/2304/2353/2354, Disconnect the connection cable which connects between the Analog board and IBP board.



The BSM-2304A and BSM-2354A monitor have the MP506 Oximax pulse oximetry module which is attached to the Analog board. When replacing this module with a new one, check that the settings of the DIP switch SW1 on the new module are correct and that the pin protector is removed from the new module. Refer to Section 8 “Replaceable Parts List”.



Since a pin protector is attached to this socket, remove the pin protector from the socket. Otherwise, the module cannot be attached to the Analog board.

DIP switch SW1

No.	1	2	3	4
Setting	OFF	ON	ON	OFF

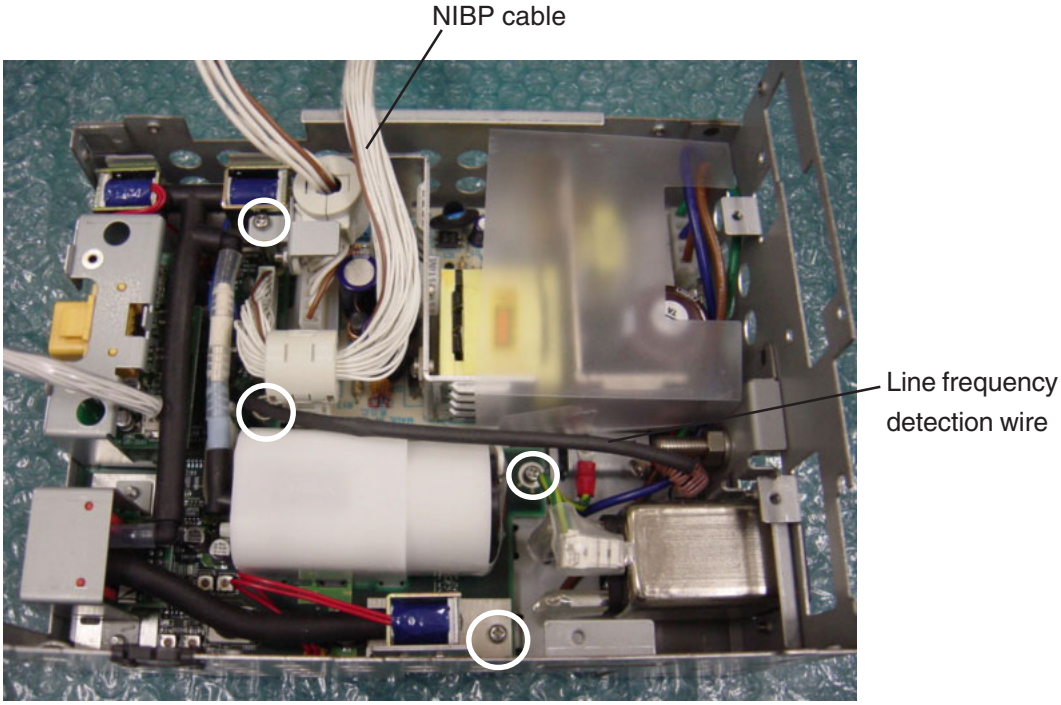
A wrong setting disables SpO_2 measurement and an “SpO_2 Module Error” message will be displayed on the screen.

Replacing the NIBP Board

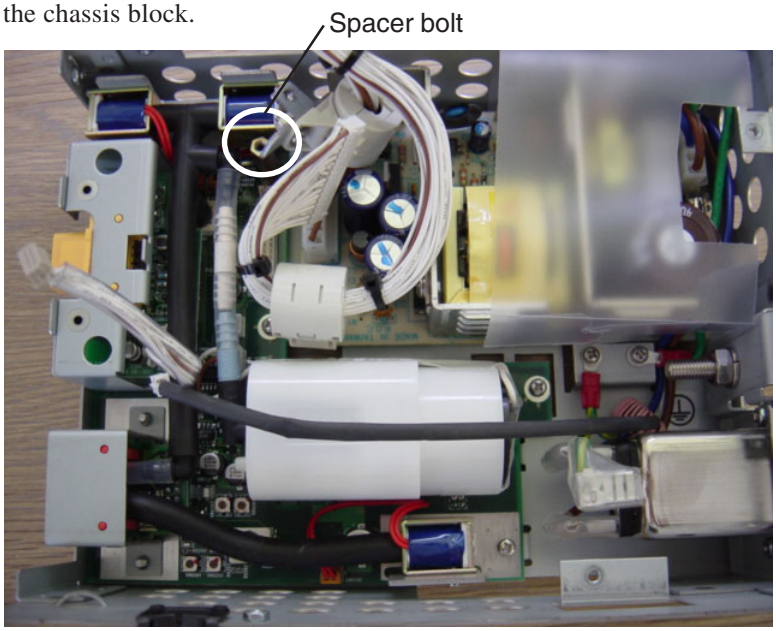
Perform the following procedure after the “Replacing the Analog Board” procedure.

1. Disconnect the NIBP cable and line frequency detection wire from the NIBP board.

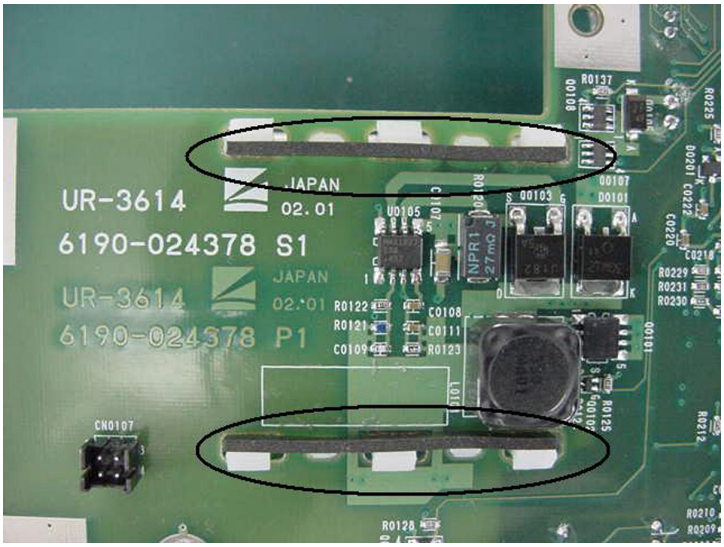
2. Remove the 4 screws (marked with circles in the following picture) which secure the NIBP board to the chassis block.



3. Remove the spacer bolt from the NIBP board and remove the NIBP board from the chassis block.



To prevent the pump holder from coming off, there is a rubber lock inserted into the one-side feet of the NIBP pump holder on the underside of the NIBP board as shown below.



When replacing the NIBP board with a new one, check that the rubber locks are inserted into the same position on the new NIBP board as the old one. Since the rubber locks are not included in NIBP board, the rubber locks are separately available if new rubber locks are necessary.

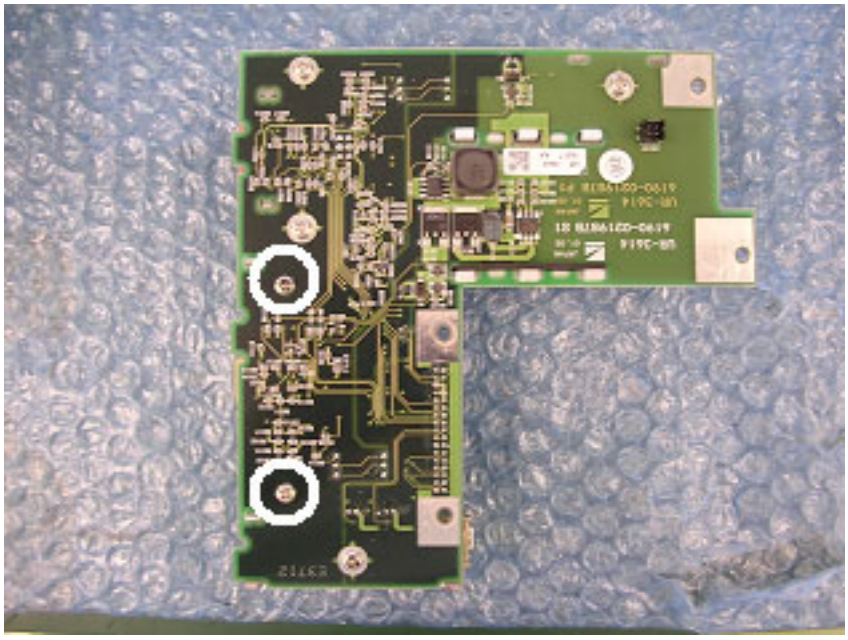
NK parts code: 6114-131066

Replacing the IBP Board

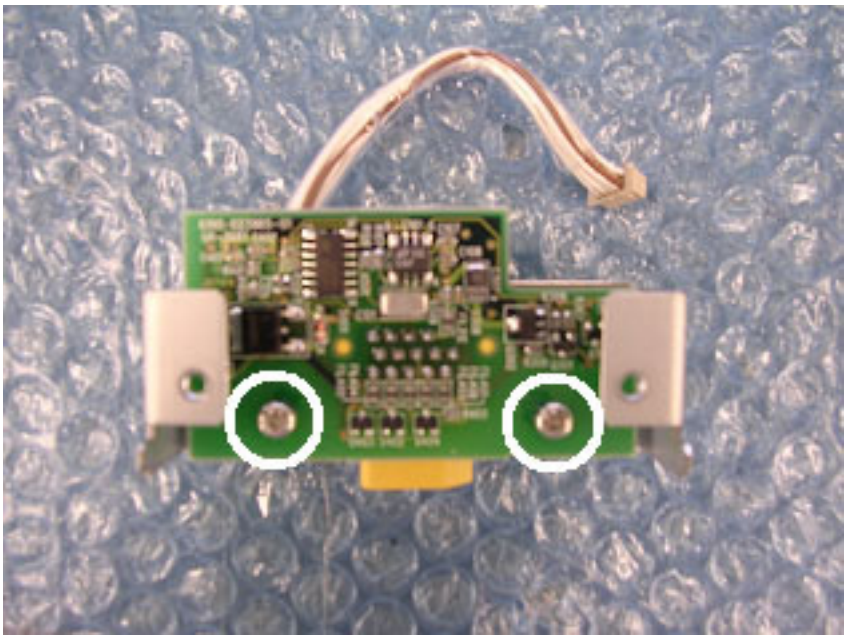
BSM-2301 and BSM-2351 have no IBP board.

Perform the following procedure after the “Replacing the NIBP Board” procedure.

1. Remove the 2 screws (marked with circles in the following figure) which secure the IBP board to the NIBP board. Remove the IBP board from the NIBP board.



2. Remove the 2 screws which secure the holder to the IBP board. Remove the IBP board from the holder.



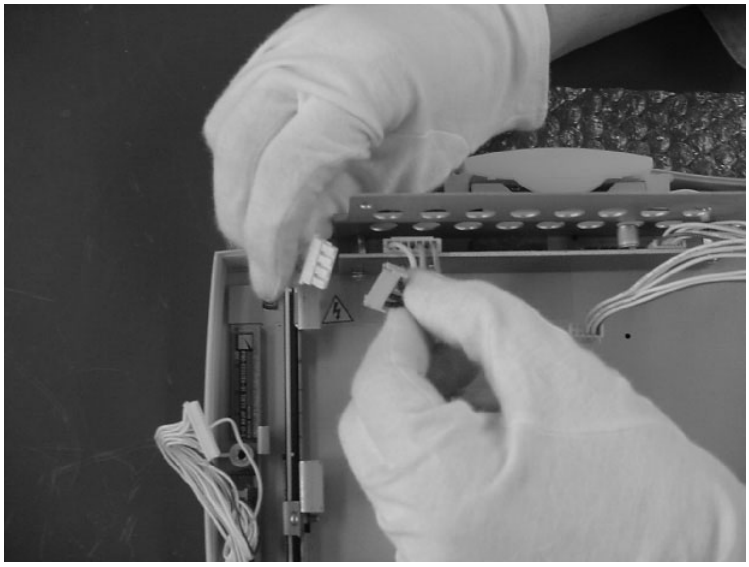
Replacing the Inverter Board (BSM-2301/2303/2304)

Perform the following procedure after the “Removing the Chassis Block” procedure.

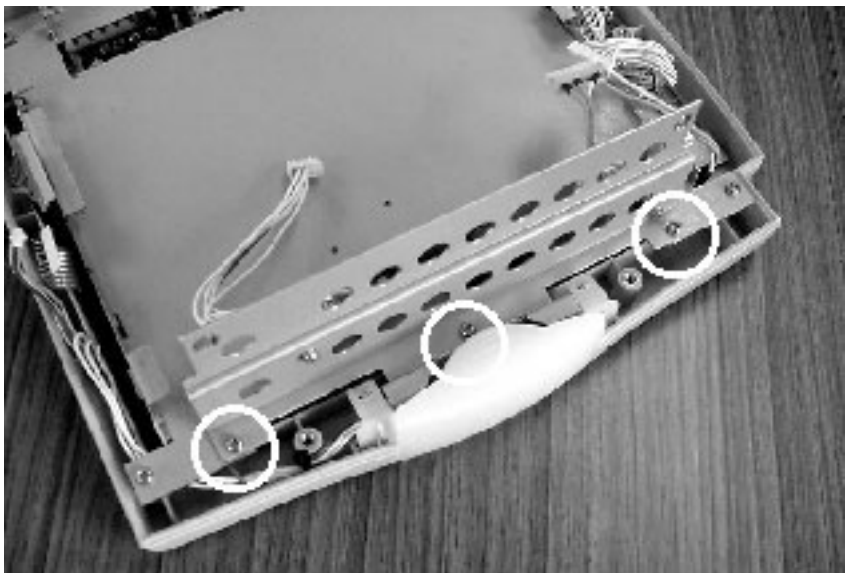
1. Disconnect the backlight lamp cable from the cable of the inverter board.

CAUTION

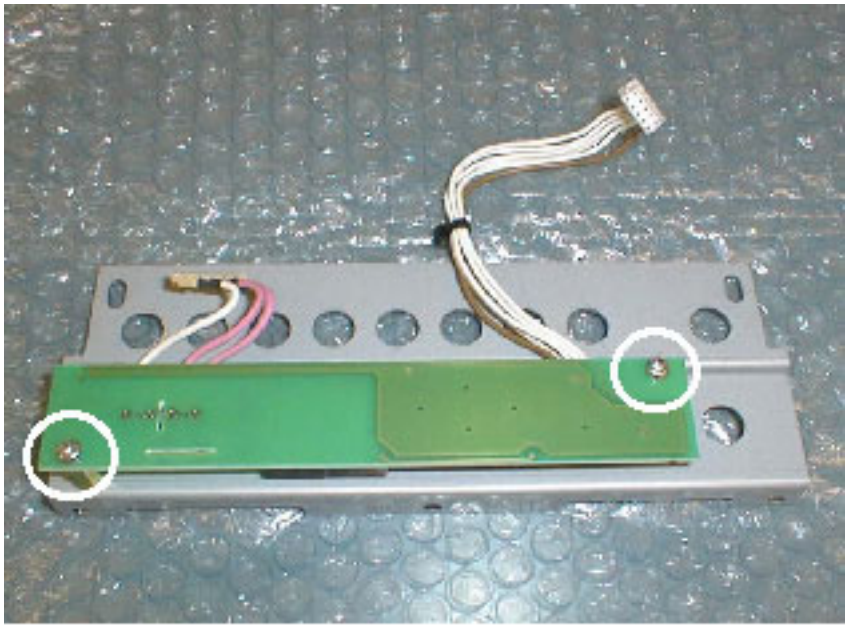
Since the pin terminals of the connector may be removed if you pull the backlight lamp cable, you must pull the connector housing for the cable disconnection. If a pin terminal is removed from the connector, you must replace the cable with a new one.

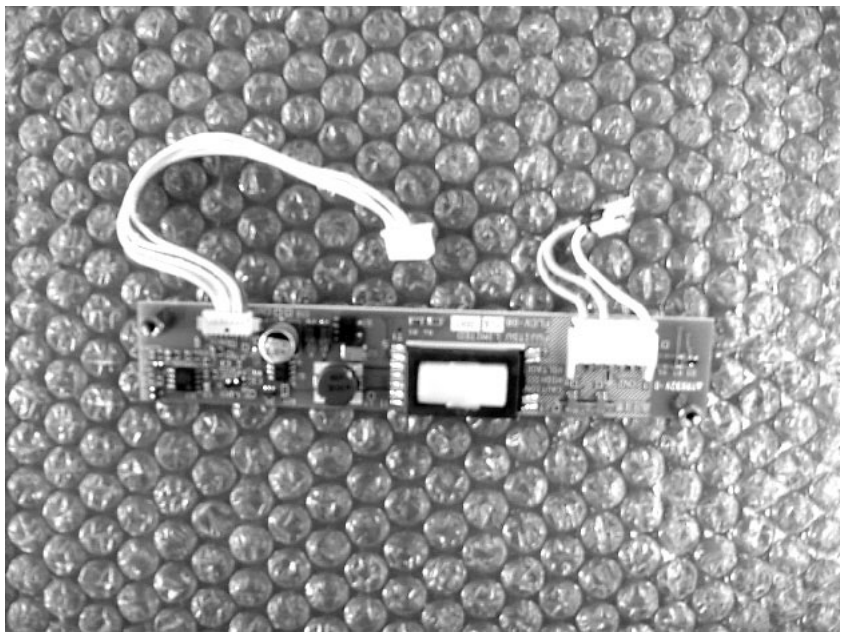


2. Remove the 3 screws which secure the inverter board with the top chassis to the front enclosure and remove the inveter board and the top chassis from the front enclosure.



3. Remove the 2 screws which secure the inverter board to the top chassis and remove the inverter board from the top chassis.

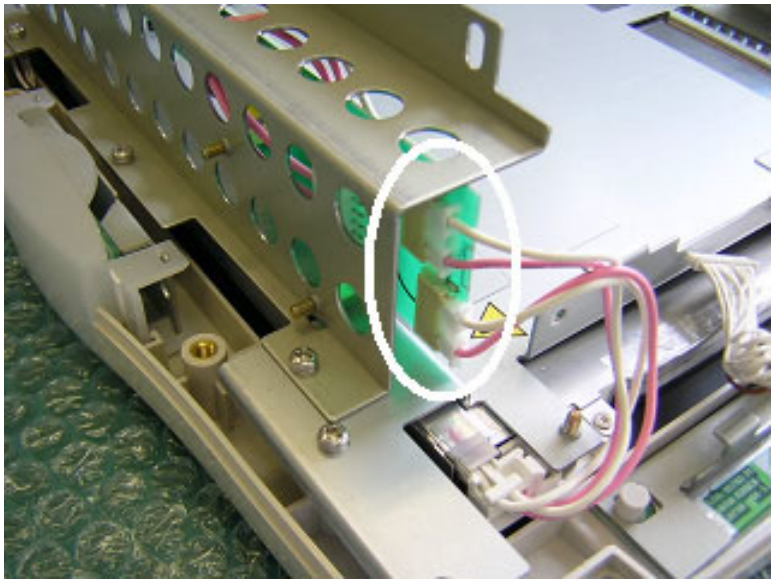




Replacing the Inverter Board and Inverter IF Board (BSM-2351/2353/2354)

Perform the follwing procedure after the “Removing the Chassis Block” procedure.

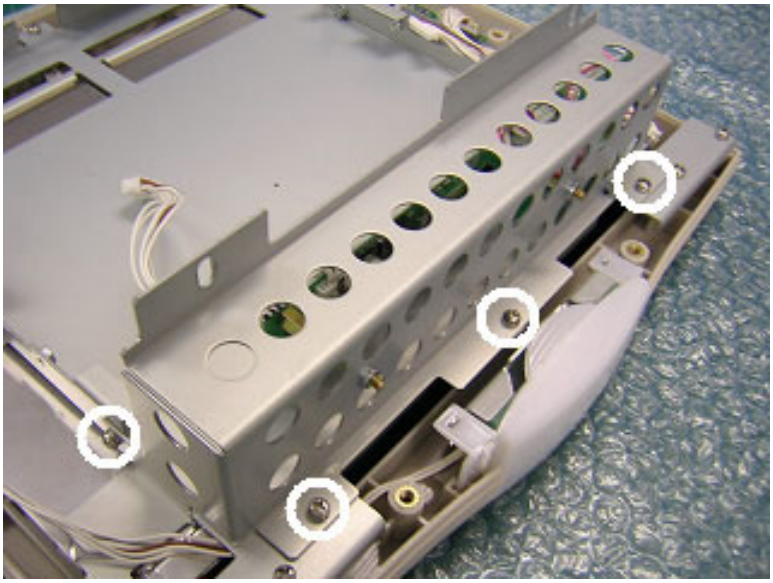
1. Disconnect the 2 cables of the backlight lamp at the inverter IF board.



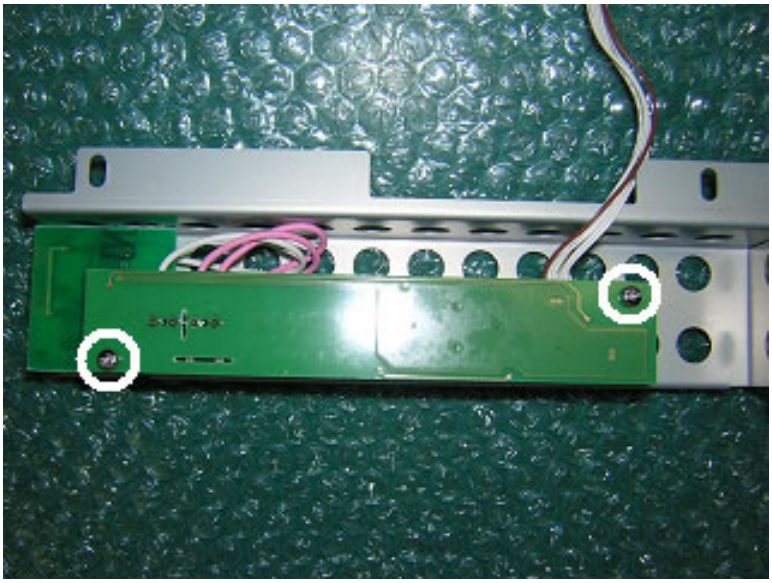
NOTE in Assembling the Instrument

You can connect the two cables to either sockets on the inverter IF board.

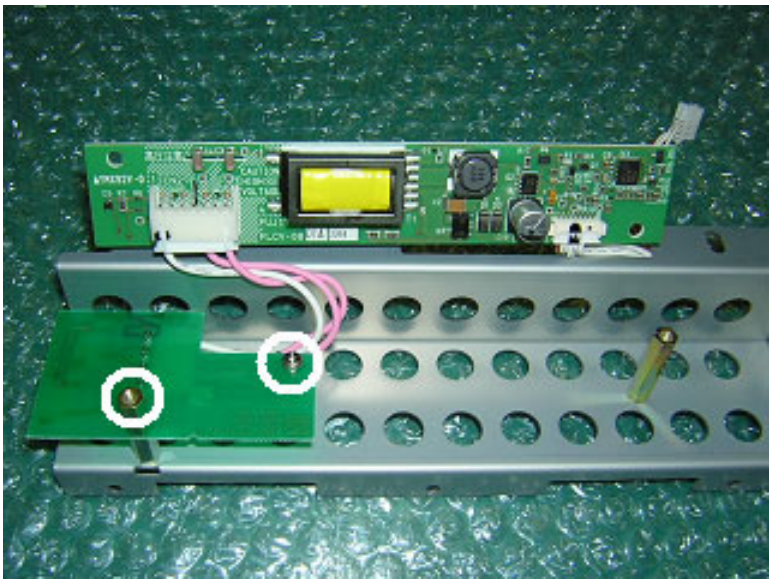
2. Remove the 4 screws marked with circles in the following picture. Remove the inverter board, inverter IF board and board holder from the front enclosure.



3. Remove the 2 screws marked with circles in the following picture and remove the inverter board from the board holder.



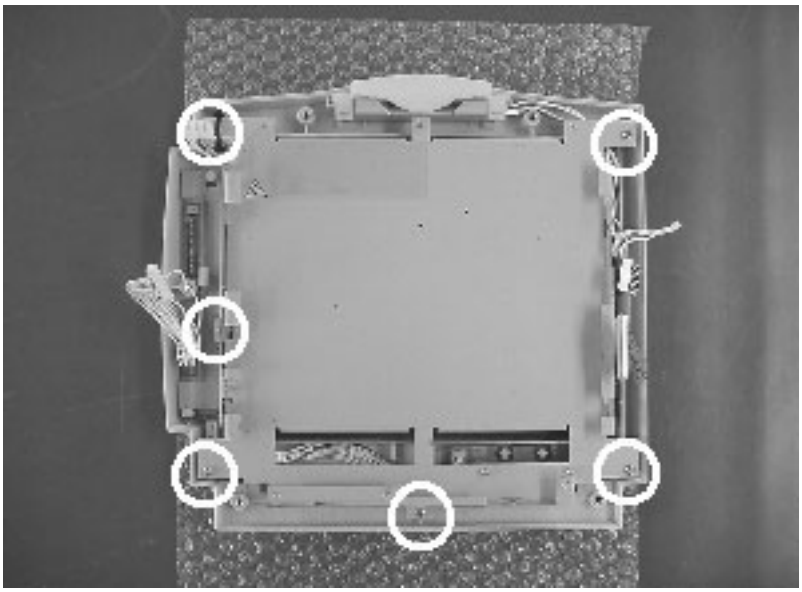
4. Remove the spacer bolt and screw marked with circles in the following picture. Remove the inverter IF board from the board holder.



Replacing the LCD Unit (BSM-2301/2303/2304)

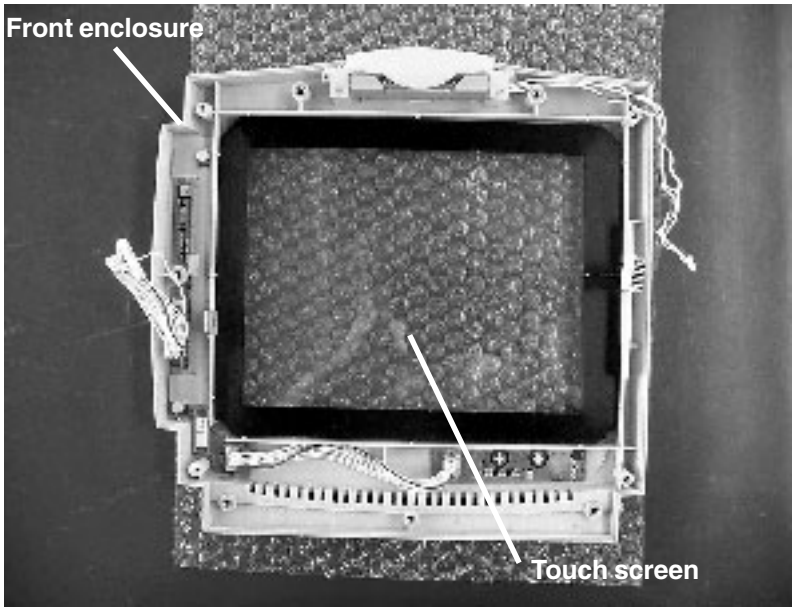
Perform the following procedure after the “Replacing the Inverter Board (BSM-2301/2303/2304)” procedure step 2.

1. Remove the 6 screws which secure the LCD unit with the holder to the front enclosure and remove the LCD unit and the holder from the front enclosure.

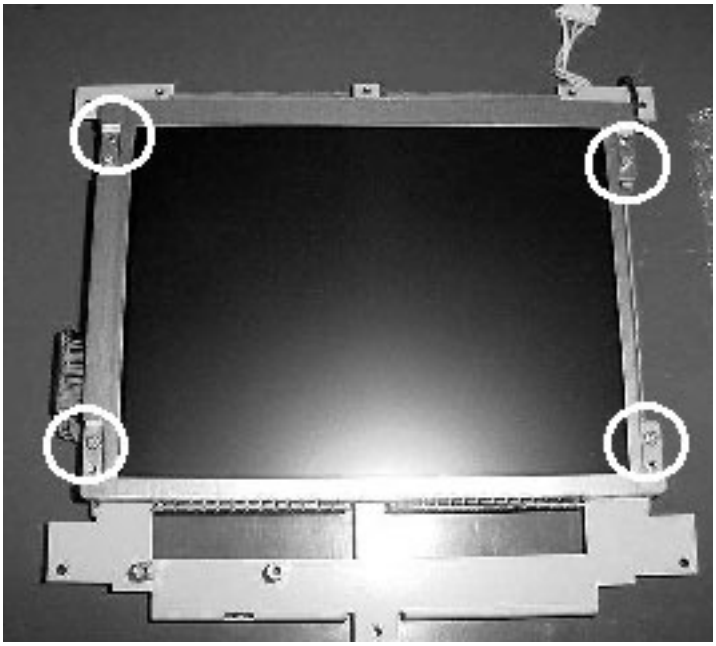


CAUTION

- **If the LCD unit is adhered to the touch screen of the front enclosure, carefully peel the touch screen off from the edges to the center.**
- **Since the touch screen is covered with glass, do not apply excessive mechanical shock such as dropping or pressure to the touch screen.**
- **Pay attention to the sharp glass parts such as the touch screen edges. It can cause cuts and injuries.**



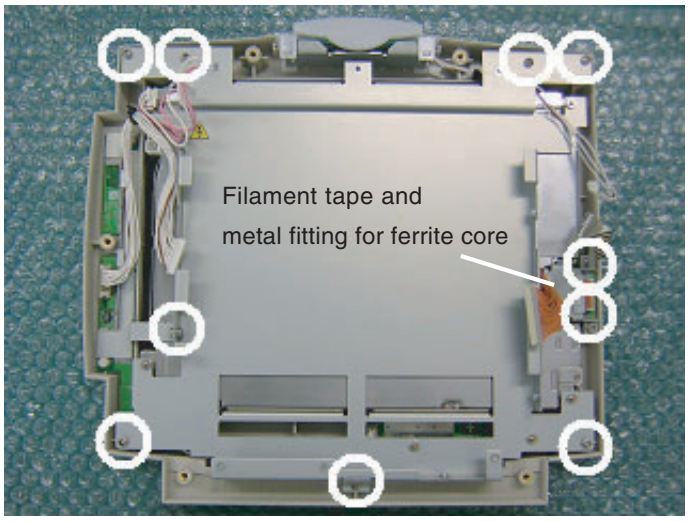
2. Remove the 4 screws which secure the LCD unit to the holder and remove the LCD unit from the holder.



Replacing the LCD Unit (BSM-2351/2353/2354)

Perform the following procedure after the “Replacing the Inverter Board and Inverter IF board (BSM-2351/2353/2354) procedure step 2.

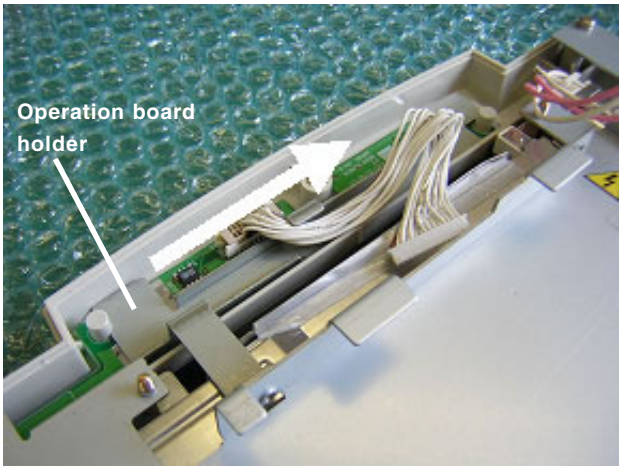
1. Remove the filament tape which covers the touch screen cable.Remove the 10 screws marked with circles in the following picture. Remove the metal fitting for the ferrite core of the cable between the MAIN board and LCD IF board.

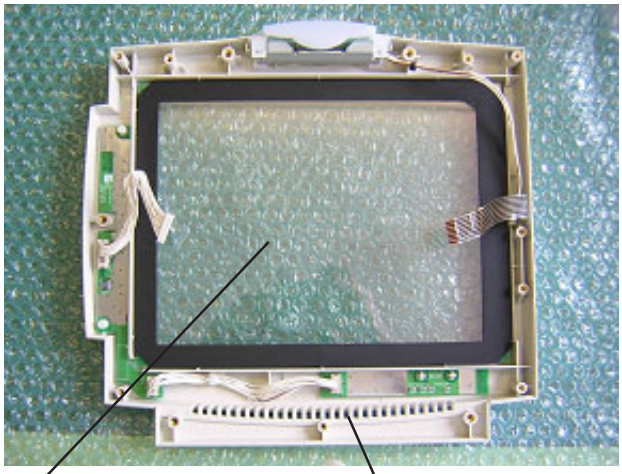


CAUTION in Assembling the Instrument

To prevent the cable between the Operation and MAIN boards from being damaged at the metal edge of the new LCD unit, attach a vinyl tape such as filament tape around the edge of the LCD unit. For the proper tape position, see the old LCD unit. Before taping, clean the tape position with alcohol.

2. Slide the operation board holder as shown below and remove the holder. Remove the LCD unit and LCD holder from the front enclosure.

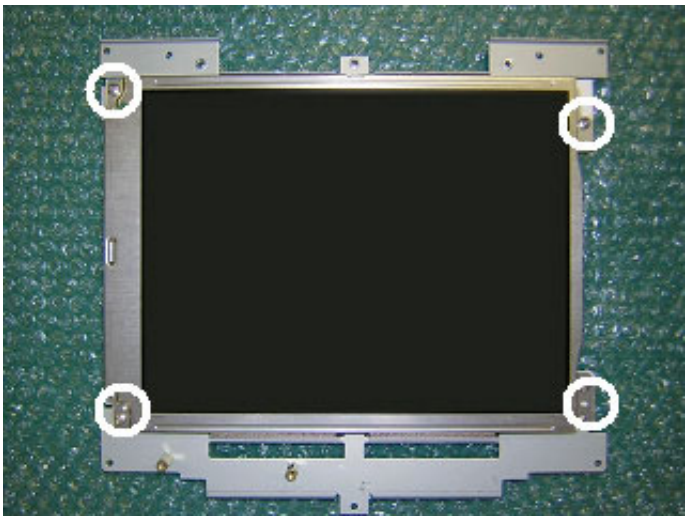




CAUTION

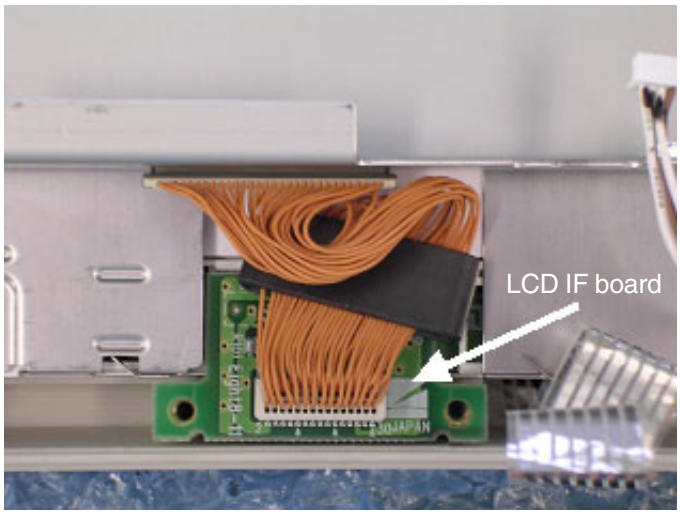
- **If the LCD unit is adhered to the touch screen of the front enclosure, carefully peel off the touch screen from the edges to the center.**
- **Since the touch screen is covered with glass, do not apply excessive mechanical shock such as dropping or pressure to the touch screen.**
- **Be careful the sharp glass parts such as the touch screen corner edges. They can cause cuts and injuries.**

3. Remove the 4 screws marked with circles in the following picture. Remove the LCD unit from the LCD holder.



Replacing the LCD IF Board (BSM-2351/2353/2354)

Remove the LCD IF board from the LCD unit after the “Replacing the LCD Unit” procedure.



CAUTION in Assembling the Instrument

To connect the LCD IF board to the LCD unit, align the connectors of the LCD unit and LCD IF board and firmly press the LCD IF board until it clicks.

Replacing the Backlight Lamp Unit (BSM-2301/2303/2304)

Perform the following procedure after the “Replacing the LCD Unit (BSM-2301/2303/2304)” procedure.

1. Place the LCD unit face down on the table covered with a clean, soft and smooth material.

2. Remove the screw marked with arrow 1 in the following picture.

3. Peel off the conductive tape marked with arrow 2 in the following picture.

CAUTION

- **Since the LCD unit and lamps in the backlight lamp unit are covered with glass, do not apply a mechanical shock such as dropping or pressure to them.**
- **If a lamp in the backlight lamp unit has a small crack, the gas composition in the lamp will gradually change and the characteristics may deteriorate too much in a short period.**
- **Do not strain the cable of the backlight lamp unit.**
- **Check that the cables between the inverter board and backlight lamp unit are not damaged. If a cable has even slight damage, it may break the vinyl of the wire and short circuit may occur because a high voltage is output for the lamps through the cable.**
- **Carefully handle the edges of the backlight lamp unit and holding plate because their edges are sharp and can cause cuts and injuries.**

4. Lift the backlight lamp unit at the cable side as shown below and pull the lamp unit in the direction of the arrow in the picture.

5. Replace the lamp unit with a new one and insert the tab of the lamp unit into the groove marked with the circle in the following picture.

6. Fasten the lamp unit with the screw. It requires approximately 1.5 kgf torque with a torque controllable screwdriver.

Replacing the Backlight Lamp (BSM-2351/2353/2354)

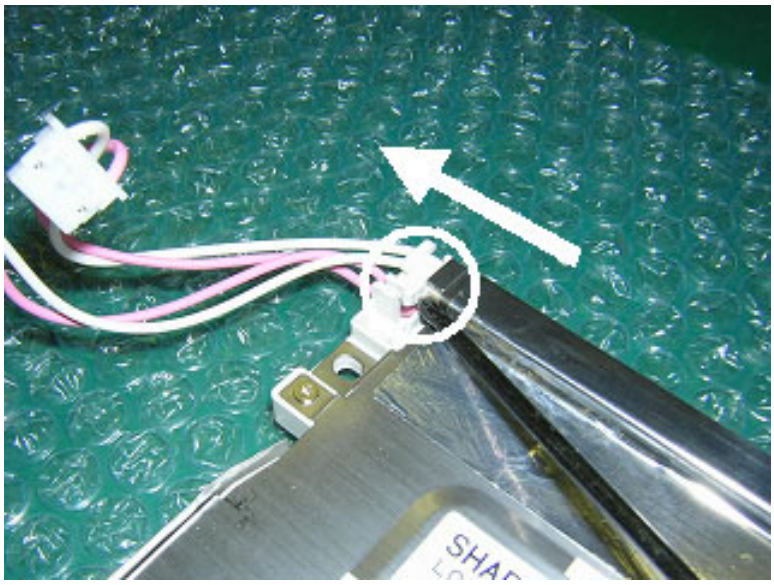
Perform the following procedure after the "Replacing the LCD Unit (BSM-2351/2353/2354)" procedure.

1. Put the LCD unit face down on a table covered with a clean, soft and smooth material.

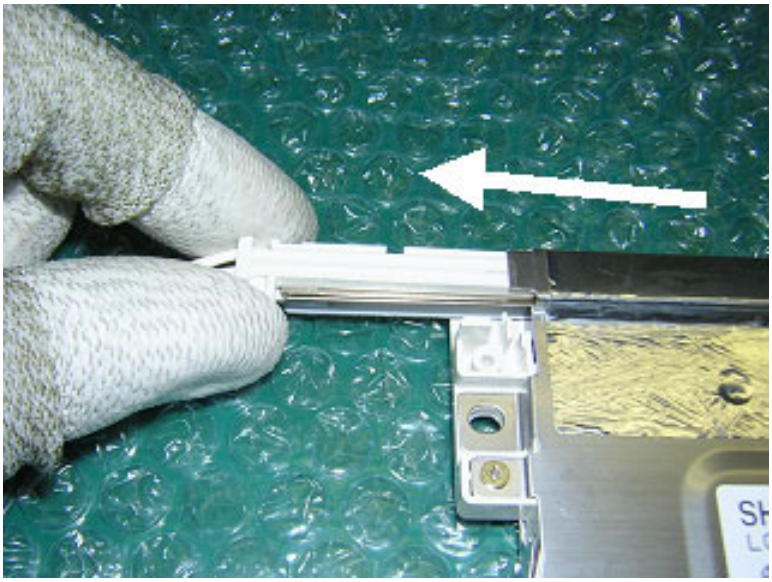
CAUTION

- **Since the LCD unit and backlight lamp are glass, do not apply a mechanical shock such as dropping or pressure to them. If the backlight lamp gets even a small crack, the gas composition in the lamp will gradually change and the characteristics may deteriorate too much in a short period.**
- **Do not strain the cable of the backlight lamp.**
- **Check that the cables of the backlight lamp are not damaged. If a cable has even slight damage, it may break the vinyl of the wire and short circuit may occur because a high voltage is output to the lamps through the cable.**
- **Dispose of used backlight lamps according to your local laws because fluorescent material is used.**

2. Remove the connector marked with a circle in the following picture by using a flat-blade screwdriver.



3. Remove the backlight lamp from the LCD unit as shown with the arrow.



Replacing the Lithium Battery

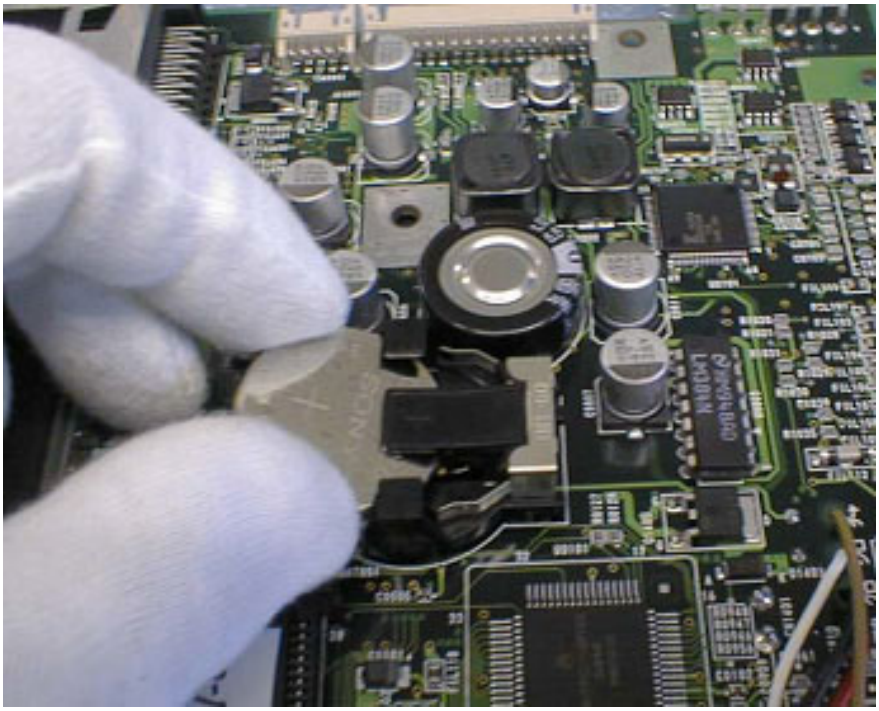
Perform the following procedure after the “Replacing the MAIN Board” procedure.

1. Replace the lithium battery on the MAIN board with a new one as shown below.

   After the battery replacement, check the continuity between the battery terminal and receptacle terminal with a multimeter.

CAUTION

- **Use a glove to handle the new lithium battery. If you touch it with your bare hand, it may cause an increase of resistance at the battery terminals and shorten the lifetime.**
- **Never charge, short-circuit, disassemble, deform, heat, or throw the battery into fire. This may cause overheating, explosion, or fire.**
- **Before disposing of the battery, cover it with insulation tape to prevent short circuit between the positive and negative terminals. Otherwise, the battery may heat, explode or burn if the battery is disposed of with other batteries or electrically conductive materials.**
- **Discard used batteries according to your local laws.**

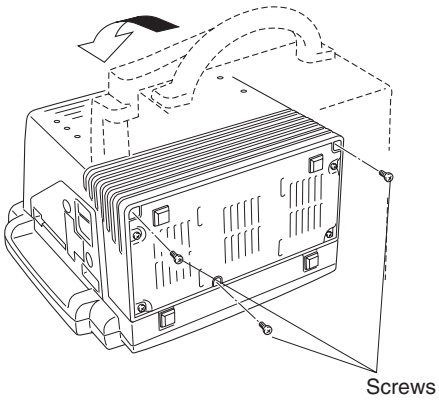


Replacing the Battery Pack

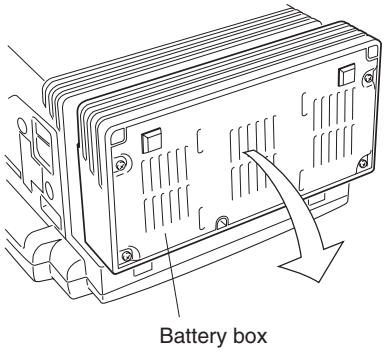
When the Recorder Module is Not Attached to the Instrument

CAUTION

- **Turn off the instrument and disconnect the power cord from the instrument before beginning the procedure.**
- **Before placing the instrument on a table, if its surface is dirty, hard or rough, cover the table with a clean, soft and smooth material to avoid making the screen dirty and damaging the screen.**

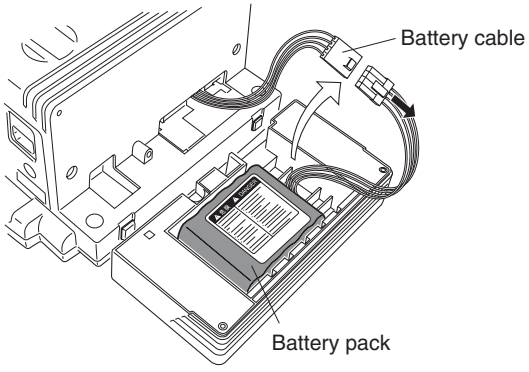


1. Place the instrument face down on the table as shown to the left.

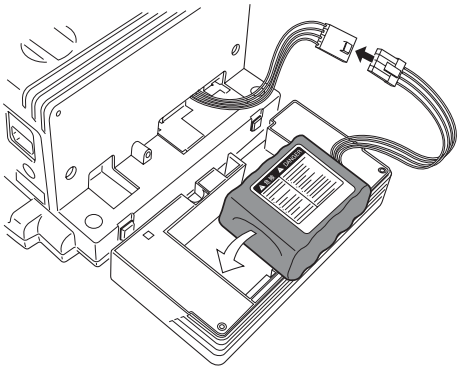


2. Remove the 3 screws from the bottom of the instrument with a long Phillips screwdriver. Separate the battery box from the instrument and put the battery box close to the instrument because the battery cable is connected to the battery pack in the battery box.

3. Disconnect the battery pack from the battery cable and remove the battery pack from the battery box.



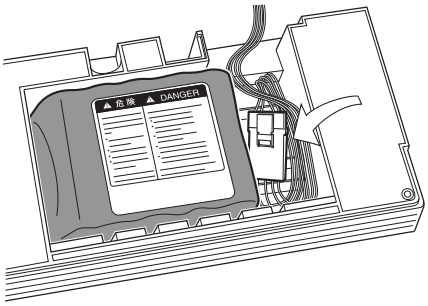
4. Connect a new battery pack to the battery cable.



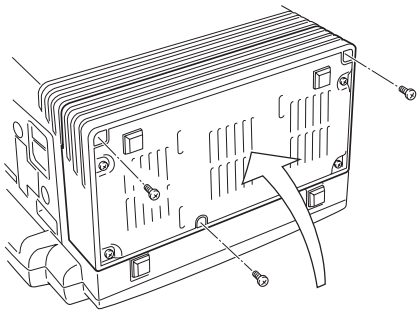
5. Install the new battery pack into the original position.

CAUTION

If the battery pack is incorrectly placed in the space for the battery pack, the battery pack does not fit the space. To check the position of the battery pack, check that the direction of the label on the battery pack is correct.



6. Arrange the cable in the space at the right side of the battery pack as shown below so that it does not come out.



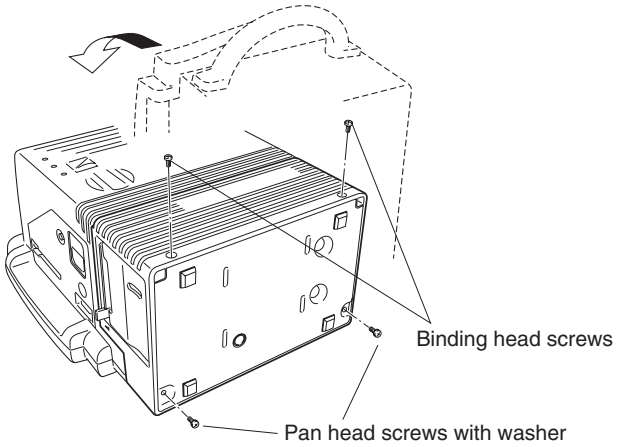
7. Fasten the battery box to the instrument with the 3 screws.

When the Recorder Module is Attached to the Instrument

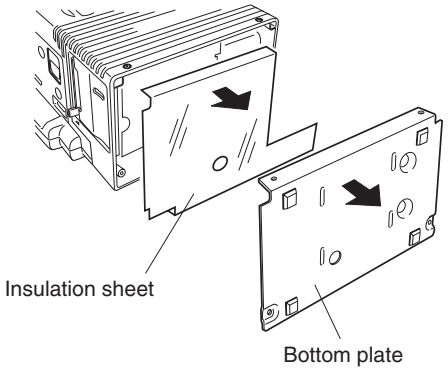
CAUTION

- **Turn off the instrument and disconnect the power cord from the instrument before beginning the procedure.**
- **Before placing the instrument on a table, if its surface is dirty, hard or rough, cover the table with a clean, soft and smooth material to avoid making the screen dirty and damaging the screen.**

1. Place the instrument face down on the table as shown below.

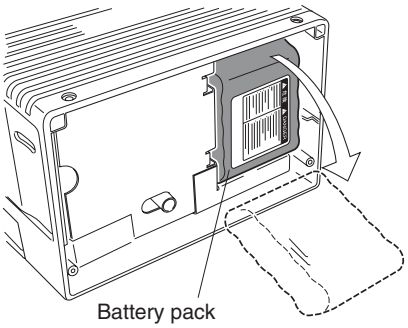


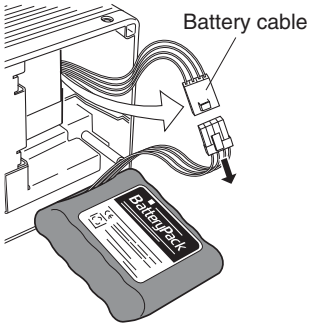
2. Remove the 2 pan head screws with washer and 2 binding head screws from the rear and bottom of the recorder module. Remove the bottom plate from the recorder module.



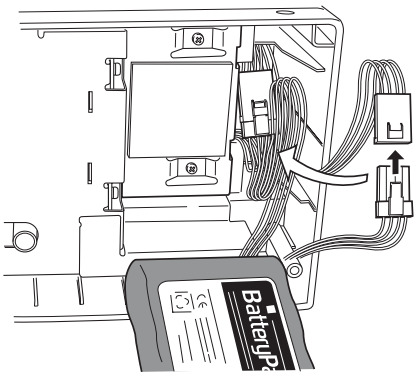
3. Remove the half transparent insulation sheet from the recorder module.

4. Gently pull the battery pack outward until the cable of the battery pack can be disconnected from the battery cable.

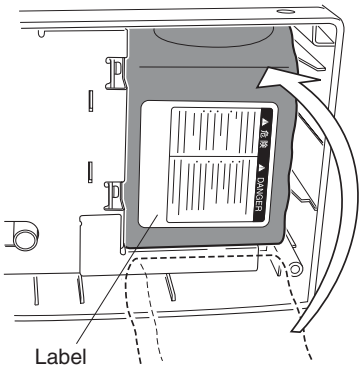




5. Disconnect the battery pack from the battery cable and remove the battery pack from the recorder module.



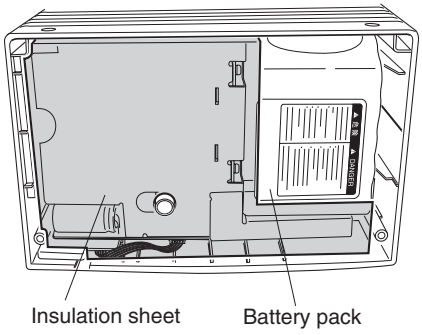
6. Connect a new battery pack to the battery cable and arrange the cable as shown below so that it does not come out.



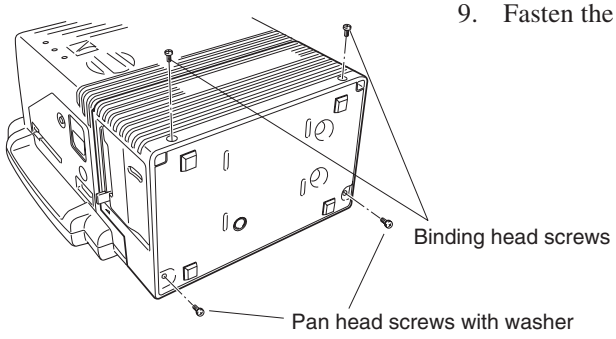
7. Install the new battery pack into the original position as shown below.

CAUTION

If the battery pack is incorrectly placed in the space for the battery pack, the battery pack does not fit the space. To check the position of the battery pack, check that the direction of the label on the battery pack is correct.



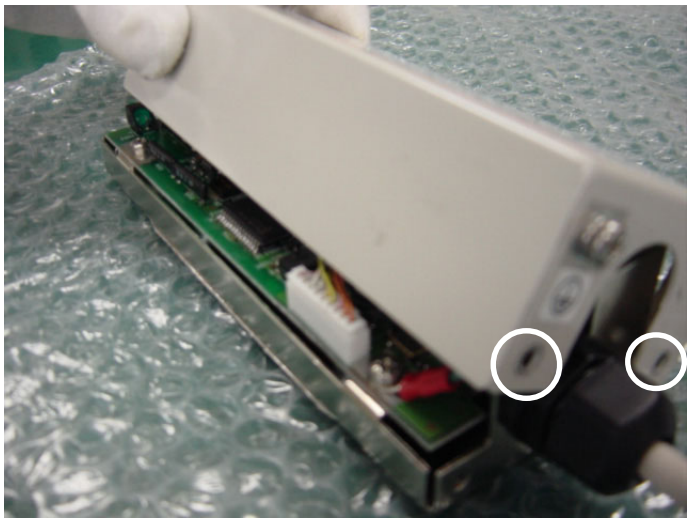
8. Put the insulation sheet back to the original position as shown below.



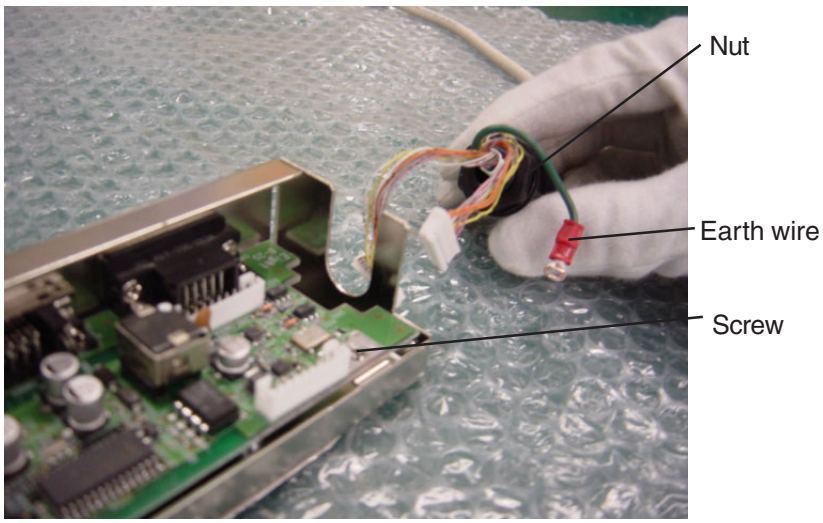
9. Fasten the bottom plate to the recorder module with the 4 screws.

Replacing the IO ANALOG OUT or IO CT OUT Board of the Optional Interface

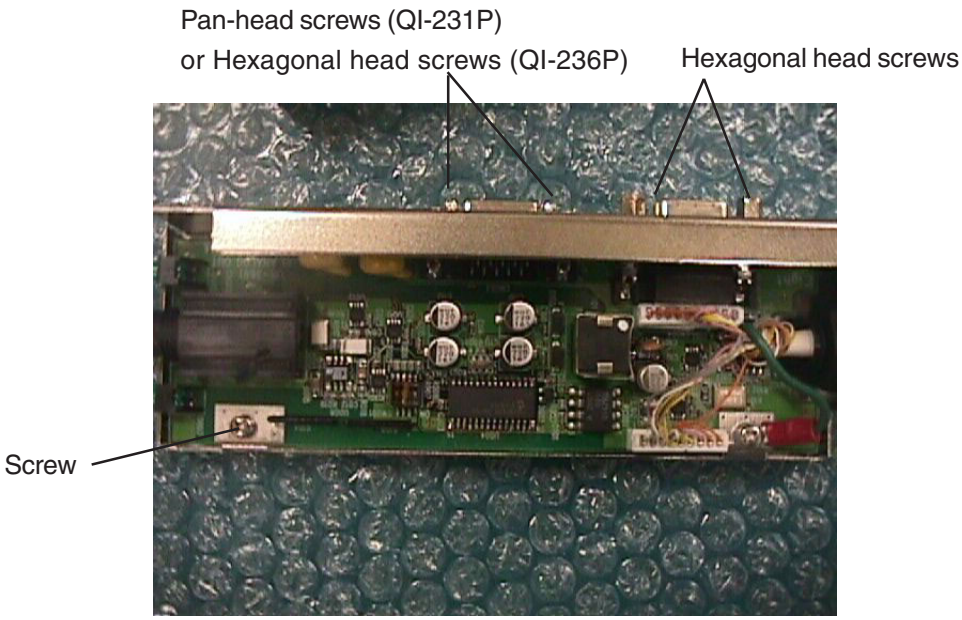
1. Remove the 6 black screws (QI-231P) or 4 black screws (QI-236P) and corrugated washers which secure the top cover to the bottom case and side panel (QI-236P has no side panel). Remove the top cover and side panel from the bottom case.



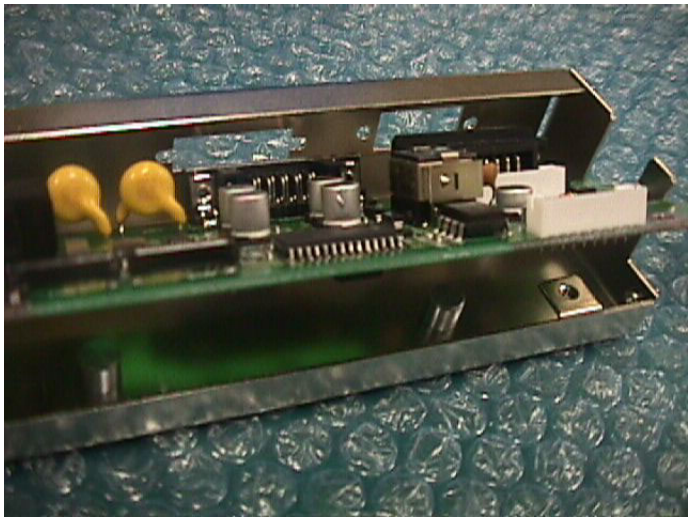
2. Remove the screw which secures the earth wire of the AUX connection cable. Disconnect the 2 connectors of the AUX connection cable from the board. Loosen the nut which fastens the AUX connection cable to the bottom case. Remove the AUX connection cable from the bottom case.



3. Remove the 2 pan head screws (QI-231P) or 2 hexagonal head screws (QI-236P) and the 2 hexagonal head screws which secure the sockets on the board to the bottom case. Remove the screw which secures the board to the bottom case.



4. Remove the board from the bottom case.



Section 6 Maintenance

To Be Replaced Periodically 6.1
Required Tools 6.1
Measuring and Test Equipment 6.2
Maintenance Check Items and Schedule 6.3
- External 6.3
- Input Conditions 6.3
- Operation 6.4
- Display 6.4
- Recorder 6.4
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- Power 6.6
- Data Backup 6.6
- Safety 6.7
- Others 6.7

To Be Replaced Periodically

We recommend the periodic replacement of the following components according to the expected life span.

NK Code No.	Description	Expected Life Span
616193	Backlight assembly for LCD unit of BSM-2301/2303/2304	Approx. 50,000 hours or 5 years and 9 months or more of continuous operation
677955	Backlight assembly for LCD unit of BSM-2351/2353/2354	
481809 (Supply code: X208)	Lithium battery for clock operation backup	Approx. 6 years or more
611893	Battery cushion sponge	Approx. 3 years or more
6114-120416	Battery cushion sponge	Approx. 3 years or more
6114-053114C	Platen roller	Approx. 6 years or more
107002	Retainer ring	Must be replaced with a new one when the platen roller is replaced.
445074	Thermal array head	Approx. 250 stacks or more of the recording paper
445109C	Paper drive motor	Approx. 6,000 stacks or more of the recording paper

Required Tools

- Long-bladed Phillips screwdriver (insulated) with magnetized tip
- Long-bladed flat screwdriver (insulated) with magnetized tip
- Anti-static bench mat connected to appropriate ground
- Anti-static wrist strap connected to appropriate ground
- 3 mm hex socket driver
- Tweezers
- Nippers
- Cable ties

Measuring and Test Equipment

To repair, check, or adjust the instrument, the following measuring and test equipment or equipment with similar function and performance is required.

Digital Voltmeter

A digital tester with at least 3-1/2 digits LCD display that can measure voltage, current, and resistance.

Cathode-ray Oscilloscope

An oscilloscope with a bandwidth of more than 1 MHz and a sensitivity of more than 10 mV/cm.

Function Generator

A function generator with a range of 1 Hz to at least 1 kHz with 1% or better frequency accuracy.

AX-800P Vital Sign Simulator

The simulator outputs simulated waveforms, i.e. ECG waveform, respiration curve, 4 blood pressure waveforms, 2 temperature fixed values, and cardiac output curve.

548631A Adapter Cable

Although the simulator has the connection cable for previous bedside monitors such as BSM-2100/3101/7000/8300/8502/8800, the new bedside monitors such as BSM-1100/2301/4100/9510 and BSS-9800 require this adapter cable instead of the previous bedside monitor connection cable.

YS-077P1 NIBP Dummy Cuff

A 700 mL container that is needed for some NIBP check items in the diagnostic check mode.

YS-077P2 NIBP Dummy Cuff

A 250 mL container that is needed for some NIBP check items in the diagnostic check mode.

6443-000022B NIBP Dummy Cuff

A 72 mL container that is needed for some NIBP check items in the diagnostic check mode.

Extension Board

Designed for the maintenance of the boards. The MAIN board and Analog board can be connected through the extension board.
The extension board consists of the following components.

Printed circuit board:	6190-022193
Connector:	611082
Connector:	611073

These components must be assembled locally.

Maintenance Check Items and Schedule

Perform this maintenance check once every six months.

A maintenance check sheet is provided at the end of this section. Make a copy of this check sheet before using it. The check items are grouped as follows:

- External
- Input conditions
- Operation
- Display
- Recorder
- Interface
- Vital sign parameters
- Power
- Data backup
- Safety
- Others

Following are the procedures for each check item.

External

Item	Check Procedure	Action
Dirt, stain or crack	Check that there is no dirt, stain and crack on the instrument.	If the instrument is dirty, clean it with a cloth moistened with water, neutral soap or alcohol. If the instrument has stain or crack, remove it or replace the stained or cracked part with a new one.
Damaged switch or key top cover	Check that there are no physically damaged switches and key top covers.	If any switch or key top cover is damaged, replace it with a new one.

Input Conditions

Item	Check Procedure	Action
Contact between input socket on the instrument and connector of connection cord	Check that there is good contact between the input socket and connector of the connection cord.	Remove the cause if there is a poor contact between them.
Input socket on the instrument or connector of connection cord	Visually check that there is no damaged input socket and connector.	If the input socket or connector is damaged, replace it with a new one.
Electrode lead wire or connection cord	Visually check that there is no damage of the lead wire and connection cord.	If the electrode lead wire or connection cord has a damage, replace it with a new one.

Operation

Item	Check Procedure	Action
Key function on the operation panel	Check that the function of each key on the control panel works correctly.	Remove the cause if the key function is wrong.
Touch screen key function	Check that the function of each key on the screen works correctly.	Remove the cause if the key function is wrong.

Display

Item	Check Procedure	Action
Crack, scratch or dirt	Check that there is no crack, scratch or dirt on the touch screen.	If there is a crack or scratch on the screen, replace it with a new one. If the screen is dirty, clean it with a soft cloth moistened with water.
Display control settings	Check that the control settings such as brightness work smoothly.	If one of the control settings has no function, remove the cause.
Minimum brightness control	Check that the waveforms and data do not disappear when the brightness is set to minimum on the screen.	Remove the cause if the waveforms or data disappear from the screen.
CRTC check	Check that there is no error on the screen when performing the CRTC checks on the Manual Check Menu screen.	Remove the cause if an error occurs.

Recorder

Item	Check Procedure	Action
Waveform and character data on paper	Check that the waveform and character data on the paper are clear.	If the waveform or character data is not clear, clean the thermal array head. Refer to the operator's manual.
Recording paper	Check that Nihon Kohden recording paper is used.	If unspecified paper is used, replace it with Nihon Kohden specified paper.
Paper drive check	Check that the paper moves at a preset paper speed without snaking.	Remove the cause if the paper moves abnormally.
Abnormal sound	Check that the motor and gears do not generate abnormal sound.	Remove the cause if there is abnormal sound.
Mark detection	Check that the mark detection works correctly.	Remove the cause if the mark detection does not work.
Recorder check in WS Check mode	Check that there is no error on the paper when performing the recorder check in the WS Check mode. Refer to Section 3.	Replace the MAIN board or other component with a new one according to the WS Check Mode section.
Printed date and time check	Check that the correct date and time are printed on the paper.	Remove the cause if the date and time is wrong or not printed.

Interface

Item	Check Procedure	Action
Monitoring screen	Check that the same screen is displayed on the screen of the external display connected to the bedside monitor through this interface.	Remove the cause if the monitoring screen is wrong at the external display.
ECG or trigger output	Check that the signal selected at the EXTERNAL OUTPUT of the OTHER SETUP items in the SYSTEM SETUP settings is output.	Remove the cause if the selected signal is not output.
ECG and TRIG lamps	Check that the ECG or TRIG lamp is lit according to the selection on the OUTPUT Check screen of the COM Check Menu items in the MANUAL CHECK MENU.	Remove the cause if no lamp is lit.

Vital Sign Parameters

Item	Check Procedure	Action
Waveform and numeric data	Check that ECG, respiration, blood pressure waveforms, their parameters and temperature data are displayed correctly and QRS synchronous sound is generated when connecting AX-800P vital sign simulator to the instrument.	If there is anything wrong, check the connection between the AX-800P and instrument and remove the cause.
SpO_2 and NIBP	Check that the displays of SpO_2 and NIBP parameters are acceptable when applying the SpO_2 probe and NIBP cuff to a healthy person or yourself.	If there is a big difference, check the connection between the healthy person and instrument and remove the cause.
NIBP check	Check that there is no error on the screen when performing the NIBP checks on the Manual Check Menu screen.	Remove the cause if an error occurs.
Multi-parameter socket function	Check that the connection cord is recognized and the related parameter is displayed when connecting the connection cord to the socket.	If the socket has no function, plug the connection cord into the other multi-parameter sockets and check which one is wrong, connection cord or instrument.
Zero balance of IBP	Check that the blood pressure transducer is zero balanced when connecting the transducer to the instrument through the IBP connection cord and pressing “ALL ZERO” key or multi-parameter key on the screen.	If the transducer is still imbalanced after zeroing, connect the transducer to the other multi-parameter sockets and check which one is wrong, transducer or instrument.
Alarm function	Check that the alarm mark appears on the screen, the alarm indicator works, and the alarm sounds when an alarm occurs.	If there is anything wrong, check the corresponding part.
Transducer	Check that the specified sensor and transducer are used.	If the unspecified sensor or transducer is used, replace it with the specified one.

Power

Item	Check Procedure	Action
Power cord	Check that the power cord does not have any damage, poor continuity, heat, sound or smell while bending each part of the power cord.	If the power cord has a malfunction, replace it with a new one.
Ground lead	Check that the ground lead has no damage and no poor continuity while bending each part of the ground lead.	If the ground lead has a malfunction, replace it with a new one.
Fuse	Check that the specified fuses are used and not blown.	If the fuse is blown, replace it with a new one after removing the cause.
Power indicator and supply voltage check	Check that the power indicators such as the power lamp, AC power lamp and battery power lamp works properly and the correct voltages are output from the power supply unit.	Remove the cause if there is anything wrong.

Data Backup

Item	Check Procedure	Action
System Setup data backup	Check that the System Setup data is stored for a long time after the power is turned off.	The EEPROM* which stores the System Setup data is faulty if the data is not stored so long time.
Alarm setting data backup	Check that the setting data is correctly stored after turning off the instrument for 30 minutes or less and turning on.	If the setting data disappears within 30 minutes after the power off, replace the super capacitor on the MAIN board with a new one.
Clock function backup	Check that the date and time is updated when the power is turned on.	If the clock stops while the instrument is turned off, replace the lithium battery on the MAIN board with a new one.

*Since the minimum backup period of the data stored at the EEPROM and system ROM is 10 years, the data can be damaged over 10 years after the last setup or upgrade. Every 10 years, perform the upgrade and setup again.

Safety

Perform the following patient safety check after repairing the instrument.

Item		Check Procedure	Action
Protective earth impedance (refer to IEC 60601-1-18.(f))		Check that the impedance between the protective earth contact and any accessible metal part does not exceed 0.1 Ω.	Remove the cause if the impedance exceeds 0.1 Ω
Earth leakage current (refer to IEC 60601-1 19)		Check that the earth leakage current does not exceed 0.5 mArms under normal condition and 1.0 mArms under each single fault condition.	Remove the cause if the earth leakage current exceeds one of the maximum values.
Enclosure leakage current (refer to IEC 60601-1 19)		Check that the enclosure leakage current does not exceed 0.1 mArms under normal condition and 0.5 mArms under each single fault condition.	Remove the cause if the enclosure leakage current exceeds one of the maximum values.
Patient leakage current (refer to IEC 60601-1 19)	Patient leakage current	Check that the patient leakage current to type CF or defibrillation-proof type CF applied part does not exceed 0.01 mArms under normal condition and 0.05 mArms under each single fault condition.	Remove the cause if the patient leakage current exceeds one of the maximum values.
		Check that the patient leakage current to type BF or defibrillation-proof type BF applied part does not exceed 0.1 mArms under normal condition and 0.5 mArms under each single fault condition.	
	Patient leakage current (mains voltage on the applied part)	Check that the patient leakage current to type CF or defibrillation-proof type CF applied part does not exceed 0.05 mArms under each single fault condition.	
		Check that the patient leakage current to type BF or defibrillation-proof type BF applied part does not exceed 5 mArms under each single fault condition.	
Dielectric strength (refer to IEC 60601-1 20)		Check that the instrument has the following withstand voltages. • A-a1: 1500 V AC for one minute • A-f: 1500 V AC for one minute • B-a: 4000 V AC for one minute • B-d: 1500 V AC for one minute	Remove the cause if the instrument does not have all the withstand voltages.

Others

Item	Check Procedure	Action
Line voltage	Check that the line voltage is within the range of nominal voltage ±10%.	Use only the line voltage within the correct range.
Connection to other equipment	Check that the instrument is correctly connected to other equipment according to the operator's manual.	If there is a wrong connection, connect the equipment to the instrument correctly according to the operator's manual.
Vibration or resonant sound	Check that the instrument has no abnormal vibration or resonant sound.	Remove the cause of abnormal vibration or resonant sound.
Screws	Check that there are no loose screws.	If any screw is loose, tighten it.
Option check	Check that there is no error on the screen when performing the optional card checks such as ATA Card Check and Network Card Check on the Manual Check Menu screen.	Remove the cause if an error occurs.
Installation condition check	Check that the instrument is installed in a suitable location according to the operator's manual.	If the conditions are not suitable, improve them.

Maintenance Check Sheet

(Refer to the Maintenance section of the service manual for details.)

Customer: _____ Customer Address: _____

Service Personnel: _____ Service Company: _____

Instrument Name: _____ Instrument Model: _____

Instrument Serial Number: _____ Hardware Revision: _____

Software Revision: _____

External

There is no dirt, stain, and crack on the instrument.	Yes	No
There are no damaged switches and key top covers.	Yes	No
The warning and caution labels are clearly readable.	Yes	No

Input Conditions

There is good contact between the input socket on the instrument and connector of the connection cord.	Yes	No
There is no damage on the input socket and connection cord connector.	Yes	No
There is no damage and internal cut on the lead wire and connection cord.	Yes	No

Operation Keys

The function of each key on the operation panel works correctly.	Yes	No
The function of each key on the screen works correctly.	Yes	No

Display

The brightness is correctly adjusted.	Yes	No
There is no distortion on the screen.	Yes	No
Alarm indicator works properly.	Yes	No

Vital Sign Parameters

ECG waveform, heart rate, and QRS synchronous mark are properly displayed with QRS synchronous sound generated.	Yes	No
Respiration waveform and respiration rate are properly displayed.	Yes	No
Plethysmographic pulse waveform and SpO_2 data are properly displayed.	Yes	No
NIBP data (systolic, diastolic and mean blood pressures) are acceptable.	Yes	No
Multi-parameter sockets recognize the respective connection cords and the waveforms and data are properly displayed.	Yes	No
“ALL ZERO” key and multi-parameter key on the screen allow zero balance of the blood pressure transducer.	Yes	No
Alarm functions properly.	Yes	No
Alarm sound works properly.	Yes	No
Specified sensor and transducers are used.	Yes	No

Recorder

Waveforms are clearly recorded on the paper.	Yes	No
Alphanumeric data is clearly recorded on the paper.	Yes	No
Date and time is recorded on the paper.	Yes	No
Specified recording paper is used.	Yes	No

Data Backup

System setup data is saved.	Yes	No
Clock function works properly while the instrument is turned off.	Yes	No

Power

Power cord (and ground lead) are not damaged.	Yes	No
Instrument is firmly grounded to a dedicated grounding terminal.	Yes	No
Fuse is the correct rating.	Yes	No

Safety

Protective earth impedance is less than prescribed limit.	Yes	No
Earth leakage current is less than prescribed limits.	Yes	No
Enclosure leakage current is less than prescribed limits.	Yes	No
Patient leakage current is less than prescribed limits.	Yes	No
Withstand voltages of instrument are prescribed voltage and time limits or more.	Yes	No

Others

Line voltage is within the range of nominal voltage ±10%.	Yes	No
Instrument is correctly connected to other equipment.	Yes	No
All screws are tight.	Yes	No

Section 7 Adjustment

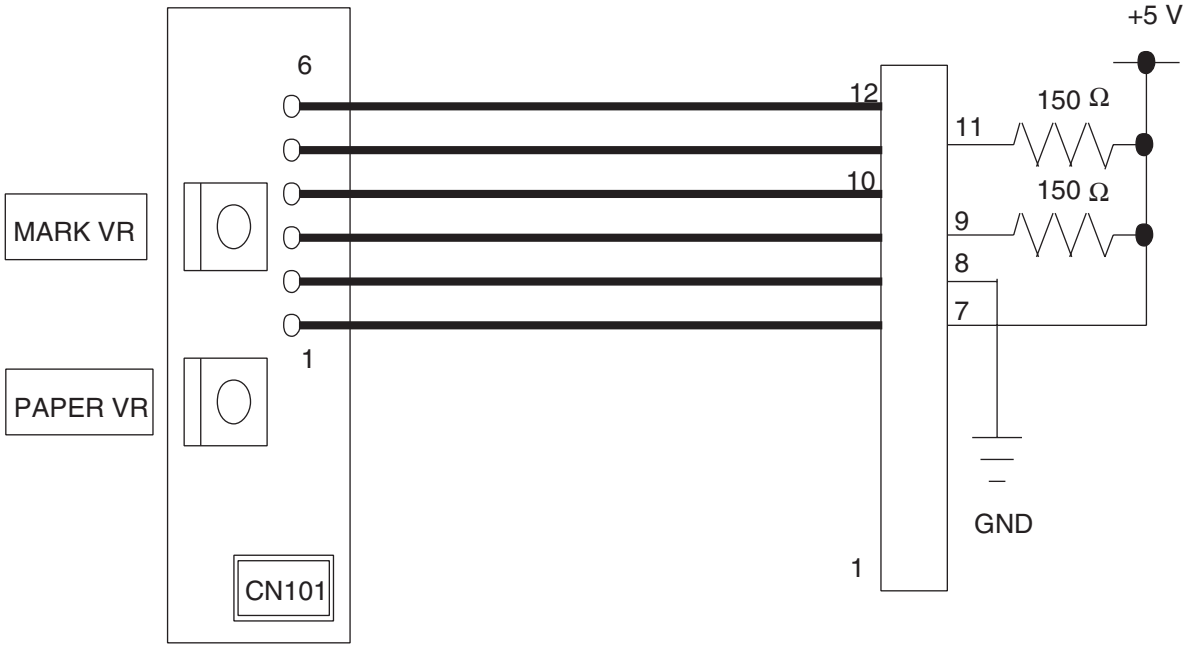
Sensors in the Recorder Unit 7.1
Adjusting the Output Voltages with Digital or Analog Multimeter 7.1

Sensors in the Recorder Unit

After you replace the sensor board of the recorder unit with a new one, adjust the paper and mark detection output voltages on the sensor control board as shown below.

Adjusting the Output Voltages with Digital or Analog Multimeter

1. Connect 150 Ω resistors to pins 9 and 11 of the 12-pin connector cable from the sensor control board as shown below.
2. Connect +5 V DC of a +5 V DC power supply to the two resistors and pin 7 of the 12-pin connector as shown below.
3. Connect the ground terminal of the +5 V DC power supply to pin 8 of the 12-pin connector.
4. Set the recording paper inside the paper magazine according to the operator's manual "Loading the Recording Paper" in Section 2 PREPARATIONS.
5. Draw out one page of the recording paper so that the small black square on the corner of the paper is not over the mark detection sensor.
6. Adjust the PAPER VR and MARK VR so that pins 10 (PAPER output) and 12 (MARK output) of the 12-pin connector output a voltage within the range of 3.5 V DC to 4.0 V DC, respectively when the two sensors detect the white part of the paper.



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Section 8 Replaceable Parts List

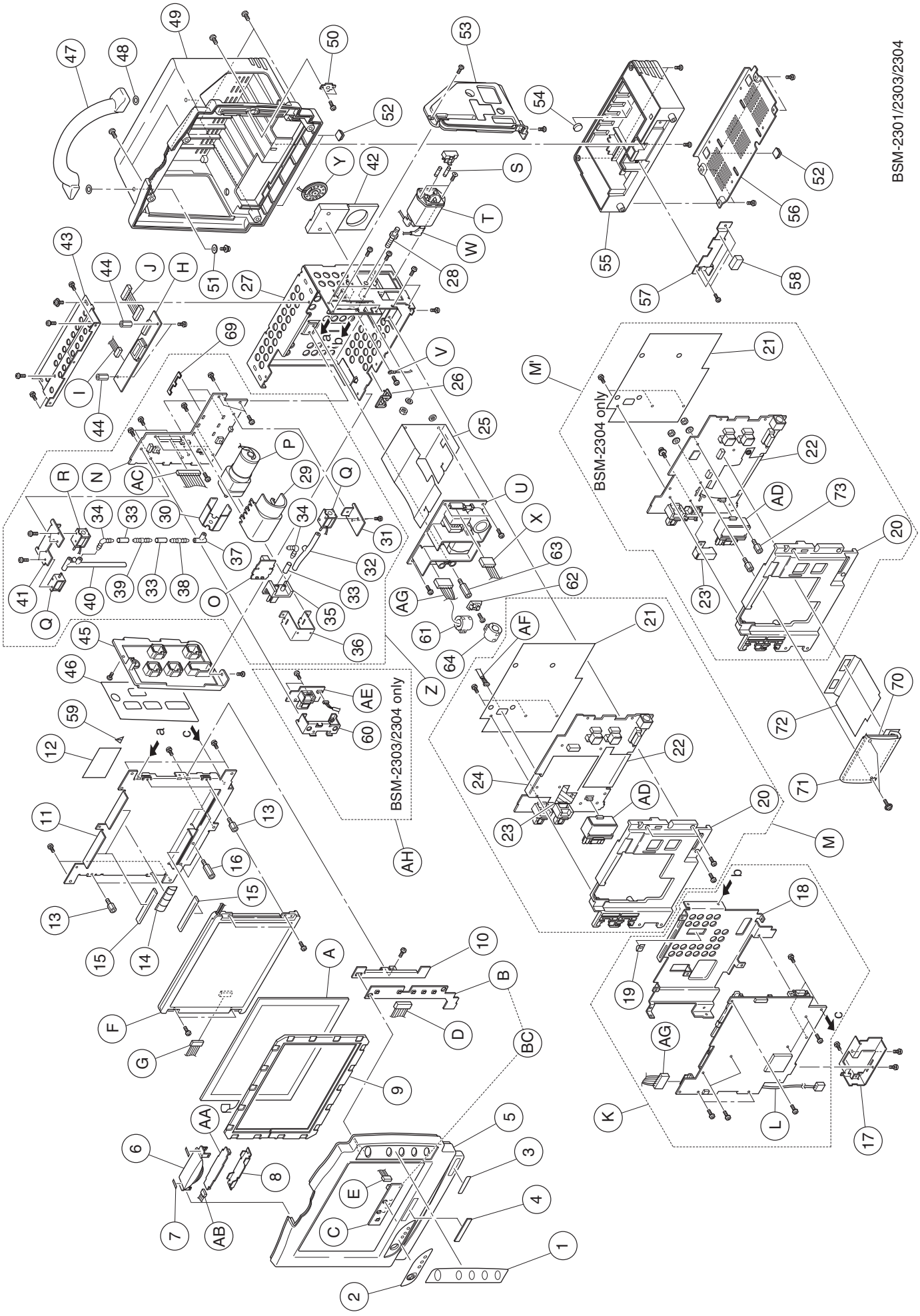
Bedside Monitor BSM-2301/2303/2304 ..... 8.2
Bedside Monitor BSM-2351/2353/2354 ..... 8.8
Optional Recorder Module WS-231P 8.14
RG-922P Recorder Unit 8.16
QI-231P Interface 8.18
QI-236P Interface 8.19

When ordering parts or accessories from your nearest Nihon Kohden Corporation distributor, please quote the NK code number and part name which are listed in this service manual, and the name or model of the unit in which the required part is located. This will help us to promptly attend to your needs. Always use Nihon Kohden parts and accessories to assure maximum performance from your instrument.

Bedside Monitor BSM-2301/2303/2304

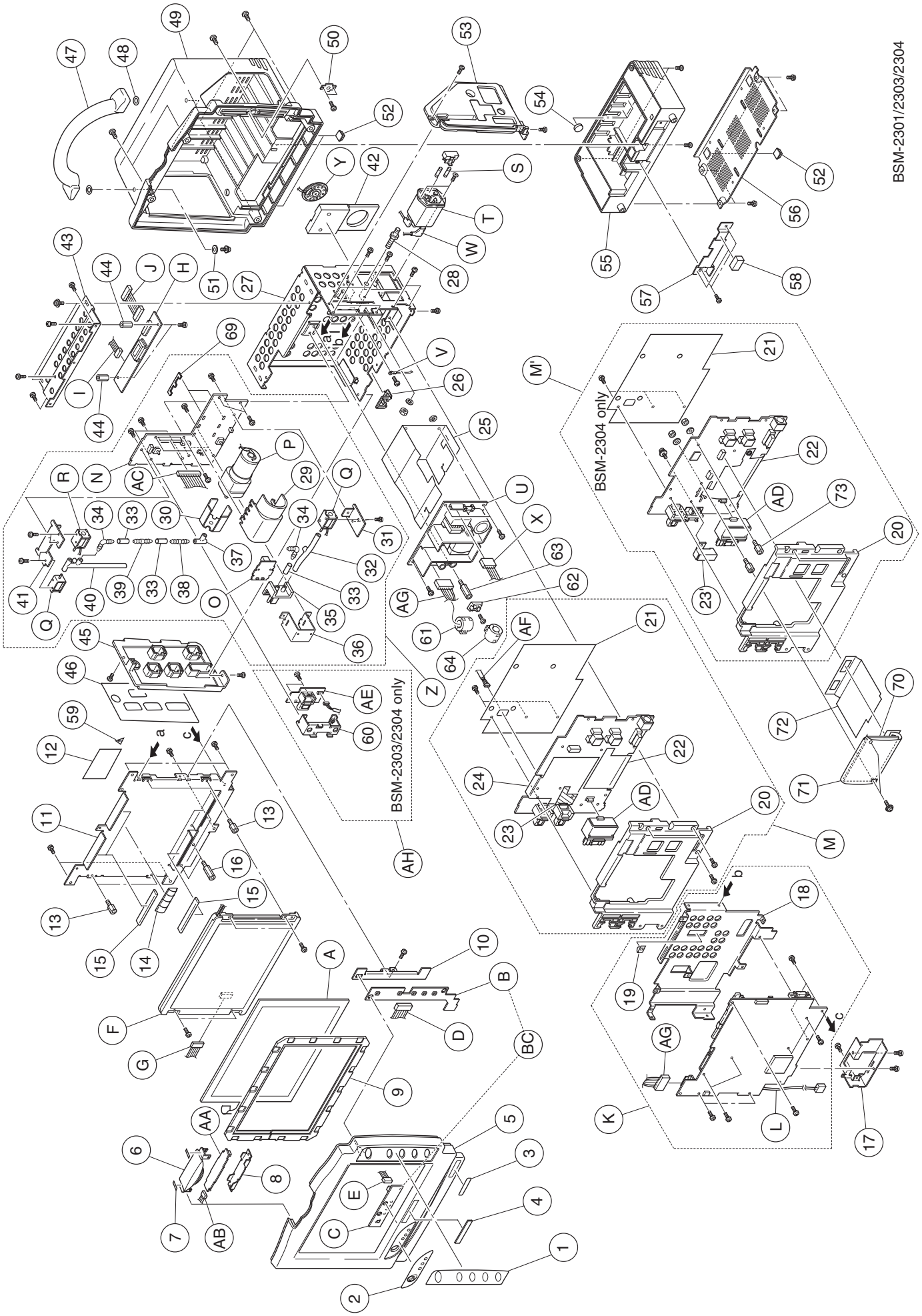
Index	NK Code No.	Qty	Description	
1	6122-004982A	1	Operation panel sheet	操作パネル
2	6123-012721B	1	Power indication sheet	スタンバイスイッチパネル
3	6124-034205	1	Model number label for BSM-2301A	BSM-2301A型式ラベル
3	6124-041322	1	Model number label for BSM-2301C	BSM-2301C型式ラベル
3	6124-034223	1	Model number label for BSM-2301K	BSM-2301K型式ラベル
3	6124-041331	1	Model number label for BSM-2303C	BSM-2303C型式ラベル
3	6124-035249	1	Model number label for BSM-2303K	BSM-2303K型式ラベル
3	6124-036792	1	Model number label for BSM-2304A	BSM-2304A型式ラベル
4	6124-026508	1	Nihon Kohden logo sheet	NIHON KOHDEN プレート
5	6111-006279C	1	Front enclosure	フロントエンクロージャ
6	6113-040157C	1	Alarm indicator	アラームインジケータ
7	6114-107877	2	Alarm indicator packing	防水パッキン
8	6114-114922B	1	Reflector	反射版
9	6112-018709	1	Touch screen packing	ﾀｯﾁﾊﾟﾈﾙ周囲のｺﾞﾑﾊﾟｯｷﾝ
10	6114-114664B	1	Operation board holder	操作ボード押さえ
11	6111-006216C	1	LCD holder	LCDシャーシ
12	6114-117001A	1	Insulation sheet between inverter board LCD holder	ｲﾝﾊﾞｰﾀﾎﾞｰﾄﾞ −LCDｼｬｰｼ間 絶縁ｼｰﾄ
13	128318	4	Spacer bolt for LCD unit	LCDユニット用間隔ボルト
14	6114-112274	1	EMC spring between LCD and LCD holder	LCD-LCDｼｬｰｼ間 ｱｰｽﾊﾞﾈ
15	6114-125991	4	Conductive gasket between LCD and LCD holder	LCD-LCDｼｬｰｼ間 ｶﾞｽｹｯﾄ
16	128345	2	Spacer bolt for Power SW board	ﾊﾟﾜｰｽｲｯﾁﾎﾞｰﾄﾞ 押さえ
17	6113-039943B	1	MAIN board holder	固定用金具
18	6112-014669A	1	MAIN board shield cover	シールド板
19	6114-107208	1	EMC spring between MAIN board and PC card	PCMCIA用ﾊﾞﾈ
20	6111-006314C	1	Plastic cover	樹脂カバ
21	6113-041129B	1	Insulation sheet for Analog board	ｱﾅﾛｸﾞﾎﾞｰﾄﾞ用絶縁ｼｰﾄ
22	6190-023094	1	ECG shield sheet	
23	6113-042182	1	SpO_2 shield sheet (small) for UR-3612	
23’	6114-128836A	1	SpO_2 shield sheet (small) for UR-3712	
24	6190-023111	1	SpO_2 shield sheet (large) for UR-3612	
25	6112-014785B	1	Power supply unit insulation cover	
26	458612	1	Edge cover of chassis	エッジホルダ
27	6142-002705B	1	Rear chassis	リア・フレーム
28	551734	1	Equipotential grounding terminal	保護接地端子
29	6113-023844D	1	Pump holder	ポンプホルダ
30	6114-073618*1	1	Sponge	ボウシンスポンジ
31	6114-114637C	1	Valve holder 1	
32	6114-114566	1	NIBP main tube M	
33	6114-117777	3	Silicon tube	シリコンチューブφ4 L22
34	531337	2	Plastic elbow tube	L型ツギテ F-3144-85
35	515542B	1	NIBP input socket	NIBPコネクタ N-NIBP-R (赤)

*1 Should be replaced with a new one when NIBP pump is replaced.


BSM-2301/2303/2304
BSM-2304 only
BSM-2303/2304 only

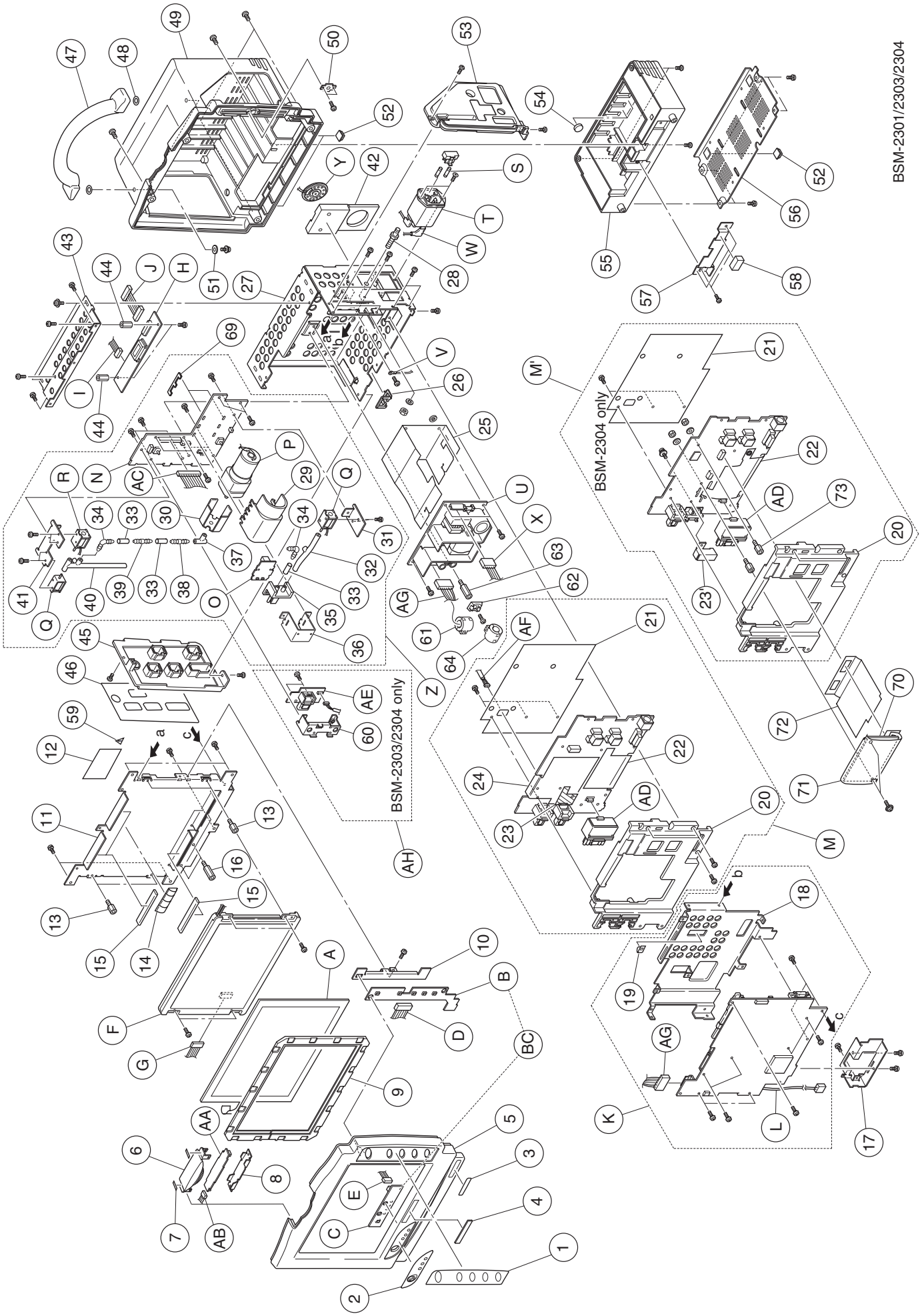
Index	NK Code No.	Qty	Description	
36	6114-114655A	1	NIBP input socket holder	
37	6114-115137	1	Plastic tee tube	
38	531346	1	Air filter	ﾎﾟﾝﾌﾟ吸気ﾌｨﾙﾀ
39	531355	1	Check valve	逆止弁
40	6113-039854A	1	NIBP main tube S	
41	6114-114646C	1	Valve holder 2	
42	6113-037125	1	Speaker holder	ｽﾋﾟｰｶﾎﾙﾀﾞ
43	6113-039925B	1	Top chassis	上部ｼｬｰｼ
44	292015	2	Spacer bolt for Inverter board	ｲﾝﾊﾞｰﾀ取り付け用
45	6112-014776C	1	Left side input panel for BSM-2301/2303	左側(入力部)ﾍﾞｾﾞﾙ
45	6112-016925A	1	Left side input panel for BSM-2304	左側(入力部)ﾍﾞｾﾞﾙ
46	6123-014523	1	Input panel sheet for BSM-2301	側面ﾊﾟﾈﾙ NK 1CH
46	6123-012971	1	Input panel sheet for BSM-2303	側面ﾊﾟﾈﾙ NK 2CH
46	6123-014559	1	Input panel sheet for BSM-2304	側面ﾊﾟﾈﾙ NL
47	6111-006305C	1	Handle	取っ手
48	315357A	2	O-ring	Oﾘﾝｸﾞ P10(ｱｶｼﾘｺﾝ)
49	6111-006332C	1	Rear enclosure	ﾘｱｴﾝｸﾛｰｼﾞｬ
50	6114-118054	1	Screwed plate	
51	6114-115663A	2	Washer for handle	
52	518272	4	Square rubber foot	ｺﾞﾑ足
53	6112-014767C	1	Right side panel	右側ﾍﾞｾﾞﾙ
54	611893	3	Battery cushion sponge	ﾊﾞｯﾃﾘ押さえｽﾎﾟﾝｼﾞ
55	6111-006297C	1	Battery enclosure	ﾊﾞｯﾃﾘｴﾝｸﾛｰｼﾞｬ
56	6113-039916B	1	Bottom plate	下部板金 (底板)
57	6114-117795A	1	Ground plate	本体ｸﾞﾗｳﾝﾄﾞ結合用
58	6114-120915	1	Conductive gasket	ｶﾞｽｹｯﾄ
59	1124-037173B	1	High voltage warning label	高圧注意ﾗﾍﾞﾙ
60	6113-044144*1	1	IBP board holder	
61	442095A	1	Ferrite core between MAIN board and power supply unit	ﾒｲﾝｰ 電源間ﾌｪﾗｲﾄ
62	619983	1	Ferrite core fitting	ﾌｪﾗｲﾄｺｱ固定具
63	128345	1	Spacer bolt	
64	488508A	1	Ferrite core between NIBP and MAIN boards	NIBPﾌｪﾗｲﾄ
69	6114-131066	2	Rubber lock	
70	634814	1	MP506 Oximax pulse oximetry module	
71	6190-014148	1	Nellcor shield	
72	6114-128845	1	Nellcor insulation sheet	
73	127925	3	Spacer bolt for UR-3712	ｶﾝｶｸﾎﾞﾙﾄ
A	601716A	1	Touch screen	ﾀｯﾁﾊﾟﾈﾙ
AA	UR-3611	1	Alarm indicator board	ｱﾗｰﾑｲﾝｼﾞｹｰﾀﾎﾞｰﾄﾞ
AB	613231A	1	Alarm indicator board cable	ｱﾗｰﾑｲﾝｼﾞｹｰﾀｹｰﾌﾞﾙ
AC	613249A	1	Cable between NIBP and MAIN boards	NIBPﾎﾞｰﾄﾞｰﾒｲﾝﾎﾞｰﾄﾞ間ｹｰﾌﾞﾙ
AD	515756C	1	ECG input socket	ECGｺﾈｸﾀ
AE	------	1	IBP board	
AF	628777*1	1	Cable between Analog and IBP boards	ANALOGﾎﾞｰﾄﾞｰIBPﾎﾞｰﾄﾞ間ｹｰﾌﾞﾙ

*1 For BSM-2303/2304


BSM-2301/2303/2304
BSM-2304 only
BSM-2303/2304 only

Index	NK Code No.	Qty	Description	
AG	613187A	1	15 V DC supply harness	ﾊﾟﾜｰｹｰﾌﾞﾙ
AH	UR-3681*1	1	IBP board (holder included)	
B	------	1	Operation board	操作ﾎﾞｰﾄﾞ
BC	UR-3644	1	Operation & Power SW boards	
C	------	1	Power SW board	ﾊﾟﾜｰｽｲｯﾁﾎﾞｰﾄﾞ
D	613213A	1	Cable between Operation and MAIN boards	ｿｳｻﾌﾞｹｰﾌﾞﾙ
E	613222A	1	Cable between Operation and Power SW boards	ﾊﾟﾜｰｽｲｯﾁｹｰﾌﾞﾙ
F	601707	1	LCD unit	LCDﾕﾆｯﾄ
G	613196A	1	Cable between LCD unit and MAIN boards (Ferrite core included)	LCDﾃﾞｼﾞﾀﾙﾃﾞｰﾀｹｰﾌﾞﾙ
H	539463	1	Inverter board	ｲﾝﾊﾞｰﾀﾎﾞｰﾄﾞ
I	613151A	1	Cable between MAIN and Inverter boards	ｲﾝﾊﾞｰﾀｹｰﾌﾞﾙ
J	613258A	1	Cable between Inverter board and LCD unit	ﾊﾞｯｸﾗｲﾄﾖｳｹｰﾌﾞﾙ
K	UR-3610	1	MAIN board (The shield cover and battery cable are included)	ﾒｲﾝﾎﾞｰﾄﾞ
L	613828A	1	Rechargeable battery connection cable	ﾊﾞｯﾃﾘｹｰﾌﾞﾙ
M	UR-3612	1	Analog board for BSM-2301/2303 (The plastic cover, insulation sheet and three shield sheets are included.)	ｱﾅﾛｸﾞﾎﾞｰﾄﾞ
M'	UR-3712	1	Analog board for BSM-2304 (The plastic cover, insulation sheet and three shield sheets are included.)	ｱﾅﾛｸﾞﾎﾞｰﾄﾞ
N	------	1	NIBP board	NIBPﾎﾞｰﾄﾞ
O	------	1	Hall sensor board	ｶﾌ･ﾎｰｽ認識用ｾﾝｻﾎﾞｰﾄﾞ
P	532149	1	NIBP pump	ﾎﾟﾝﾌﾟ
Q	611385A	2	Solenoid valve	電磁弁
R	611394A	1	Solenoid valve	電磁弁
S	104522	2	2A fuse	ﾋｭｰｽﾞ
T	580676	1	AC inlet socket with fuse drawer	ACｲﾝﾚｯﾄ
	or the following combination			
	550067	1	AC inlet socket	ACｲﾝﾚｯﾄ
	550076	1	Fuse drawer	ﾋｭｰｽﾞﾎﾙﾀﾞ
U	550013C	1	Power supply unit	電源ﾕﾆｯﾄ
V	613169B	1	Ground wire	
W	613169A	1	Wires between AC inlet socket and power supply unit	ﾋﾗｶﾞﾀｰﾏﾙｶﾞﾀｹｰﾌﾞﾙ
X	613178A	1	AC power harness	ACｹｰﾌﾞﾙ
X	628919A	1	AC power harness for BSM-2304 only	ACｹｰﾌﾞﾙ
Y	613267B	1	Speaker	ｽﾋﾟｰｶ
Z	UR-3643	1	NIBP & Hall Sensor boards (The components such as pump, valves and tubes are included.)	ﾎﾟﾝﾌﾟ、ﾊﾞﾙﾌﾞ、ｺﾈｸﾀ配管付き

*1 For BSM-2303/2304

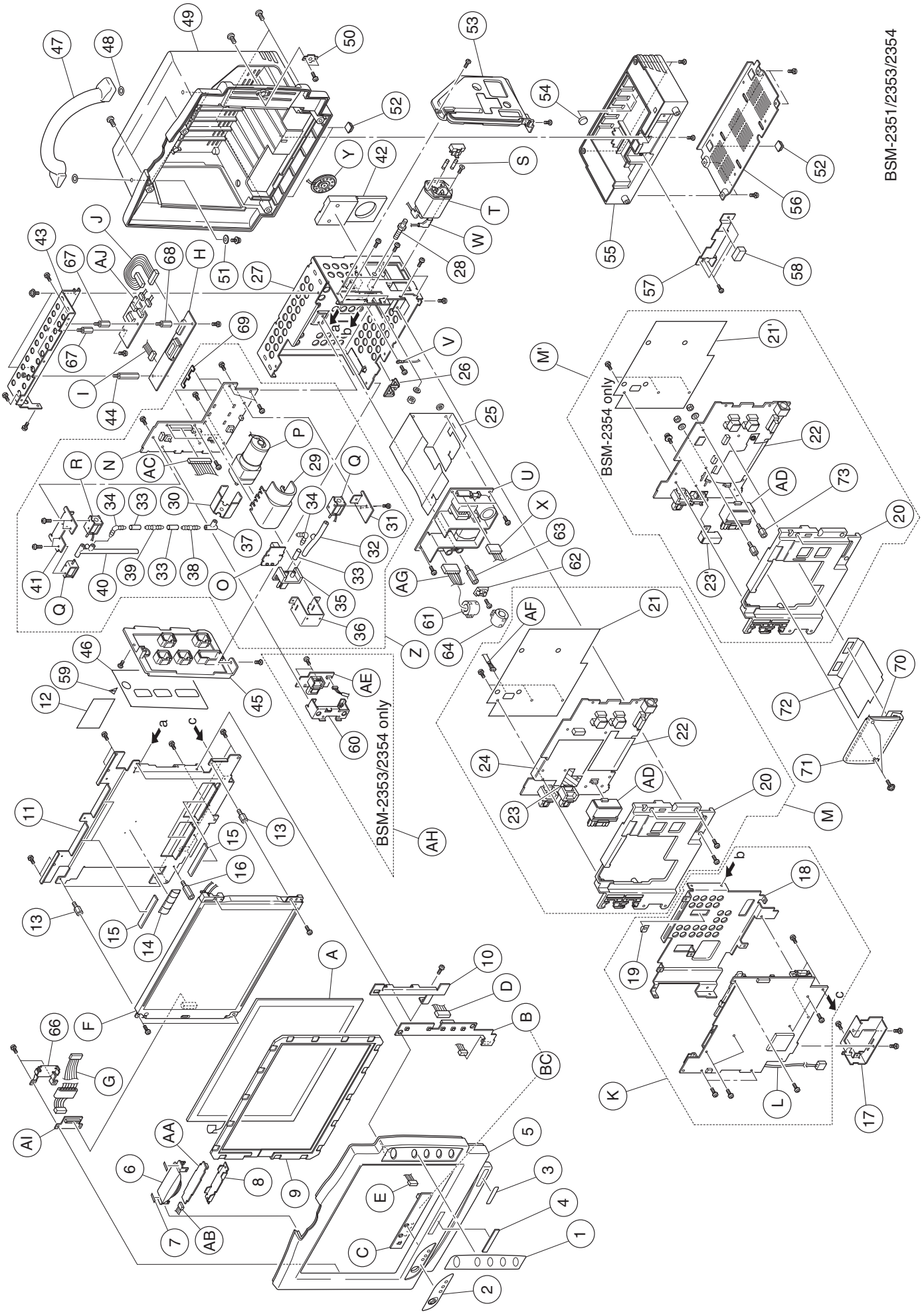

BSM-2301/2303/2304
BSM-2304 only
BSM-2303/2304 only

Bedside Monitor BSM-2351/2353/2354

Index	NK Code No.	Qty	Description	
1	6122-04982A	1	Operation panel sheet	操作ﾊﾟﾈﾙ
2	6123-012721B	1	Power indication sheet	ｽﾀﾝﾊﾞｲｽｲｯﾁ ﾊﾟﾈﾙ
3	6124-040181	1	Model number label for BSM-2351A	BSM-2351A 型式ﾗﾍﾞﾙ
3	6124-041349	1	Model number label for BSM-2351C	BSM-2351C 型式ﾗﾍﾞﾙ
3	6124-040199	1	Model number label for BSM-2351K	BSM-2351K 型式ﾗﾍﾞﾙ
3	6124-041358	1	Model number label for BSM-2353C	BSM-2353C 型式ﾗﾍﾞﾙ
3	6124-040216	1	Model number label for BSM-2353K	BSM-2353K 型式ﾗﾍﾞﾙ
3	6124-040225	1	Model number label for BSM-2354A	BSM-2354A 型式ﾗﾍﾞﾙ
4	6124-026508	1	Nihon Kohden logo sheet	NIHON KOHDEN ﾌﾟﾚｰﾄ
5	6111-08125A	1	Front enclosure	ﾌﾛﾝﾄｴﾝｸﾛｰｼﾞｬ
6	6113-040157C	1	Alarm indictor	ｱﾗｰﾑｲﾝｼﾞｹｰﾀ
7	6114-107877	2	Alarm indicator packing	防水ﾊﾟｯｷﾝ
8	6114-004922B	1	Reflector	反射板
9	6111-008107B	1	Touch screen packing	ﾀｯﾁﾊﾟﾈﾙ周囲のｺﾞﾑﾊﾟｯｷﾝ
10	6113-051341B	1	Operation board holder	操作ﾎﾞｰﾄﾞ押さえ
11	6111-008152A	1	LCD holder	LCDｼｬｰｼ
12	6114-117001A	1	Insulation sheet between inverter board and LCD holder	ｲﾝﾊﾞｰﾀﾎﾞｰﾄﾞ −LCDｼｬｰｼ間 絶縁ｼｰﾄ
13	128318	4	Spacer bolt for LCD unit	LCDﾕﾆｯﾄ用間隔ﾎﾞﾙﾄ
14	6114-112274	1	EMC spring between LCD and LCD holder	LCD-LCDｼｬｰｼ間 ｱｰｽﾊﾞﾈ
15	6114-125991	4	Conductive gasket between LCD and LCD holder	LCD-LCDｼｬｰｼ間 ｶﾞｽｹｯﾄ
16	1279252	2	Spacer bolt for Power SW board	ﾊﾟﾜｰｽｲｯﾁﾎﾞｰﾄﾞ押さえ
17	6113-039943B	1	MAIN board holder	固定用金具
18	6112-014669A	1	MAIN board shield cover	ｼｰﾙﾄﾞ板
19	6114-107208	1	EMC spring between MAIN board and PC card	PCMCIA 用ﾊﾞﾈ
20	6111-006314C	1	Plastic cover	樹脂ｶﾊﾞ
21	6113-041129B	1	Insulation sheet for Analog board	ｱﾅﾛｸﾞﾎﾞｰﾄﾞ用絶縁ｼｰﾄ
21’	6113-052643*1	1	Insulation sheet for Analog board	ｱﾅﾛｸﾞﾎﾞｰﾄﾞ用絶縁ｼｰﾄ
22	6190-023094	1	ECG shield sheet	
23	6113-042182	1	SpO_2 shield cover	
24	6190-023111	1	SpO_2 shield sheet	
25	6112-14785B	1	Power supply unit insulation cover	
26	458612	1	Edge cover of chassis	ｴｯｼﾞﾎﾙﾀﾞ
27	6142-02705B	1	Rear chassis	ﾘｱ・ﾌﾚｰﾑ
28	551734	1	Equipotential grounding terminal	保護接地端子
29	6113-023844D	1	Pump holder	ﾎﾟﾝﾌﾟﾎﾙﾀﾞ
30	6114-073618*2	1	Sponge	ﾎﾞｳｼﾝｽﾎﾟﾝｼﾞ
31	6114-114637C	1	Valve holder 1	
32	6114-114566	1	NIBP main tube M	
33	6114-117777	3	Silicon tube	シリコンチューブφ4 L22
34	531337	2	Plastic elbow tube	L 型ツギテ F-3144-85
35	515542B	1	NIBP input socket	NIBPコネクタ N-NIBP-R (赤)
36	6114-114655A	1	NIBP input socket holder	

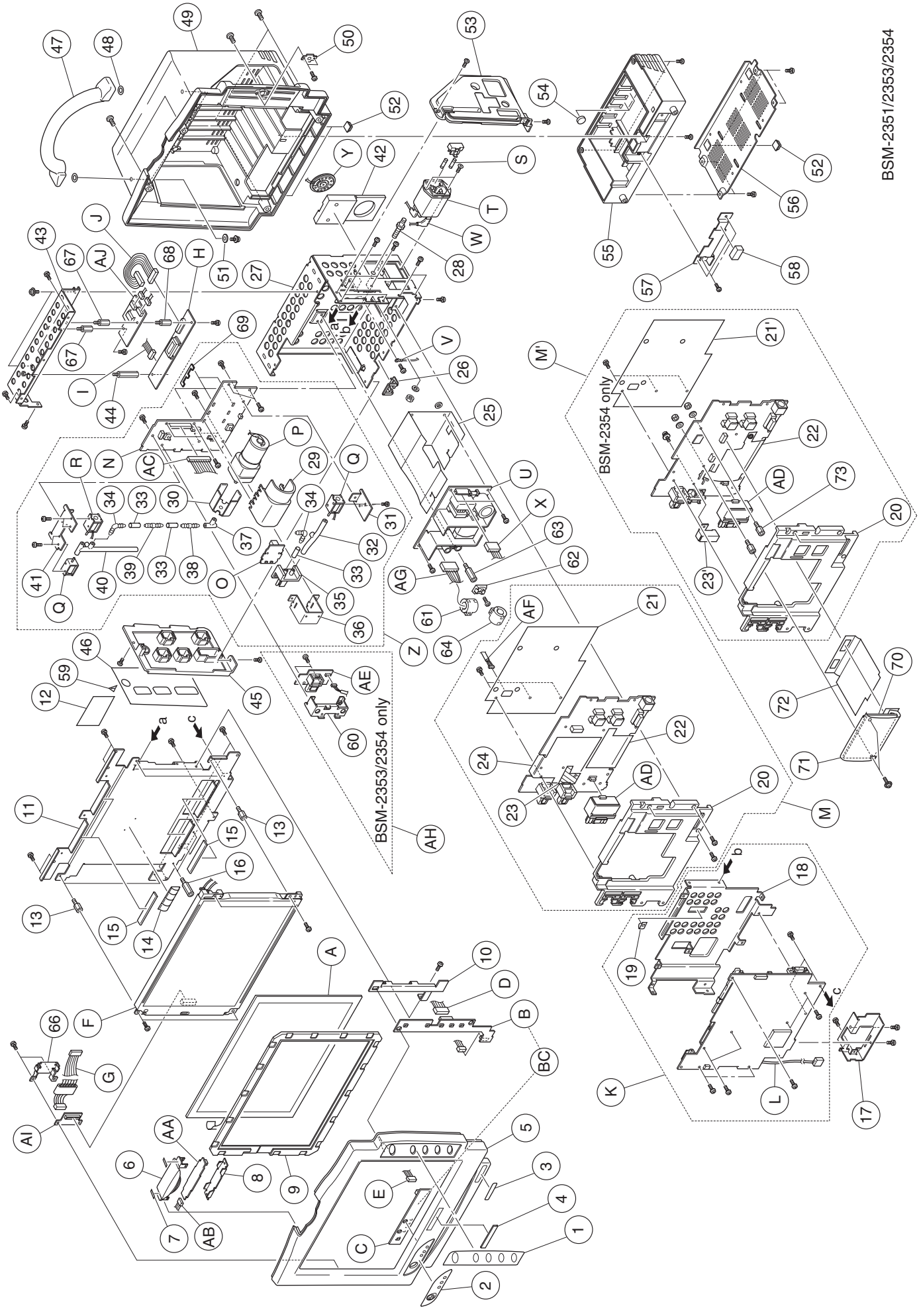
*1 For BSM-2354A

*2 Should be replaced with a new one when NIBP pump is replaced.


BSM-2351/2353/2354
BSM-2354 only
BSM-2353/2354 only

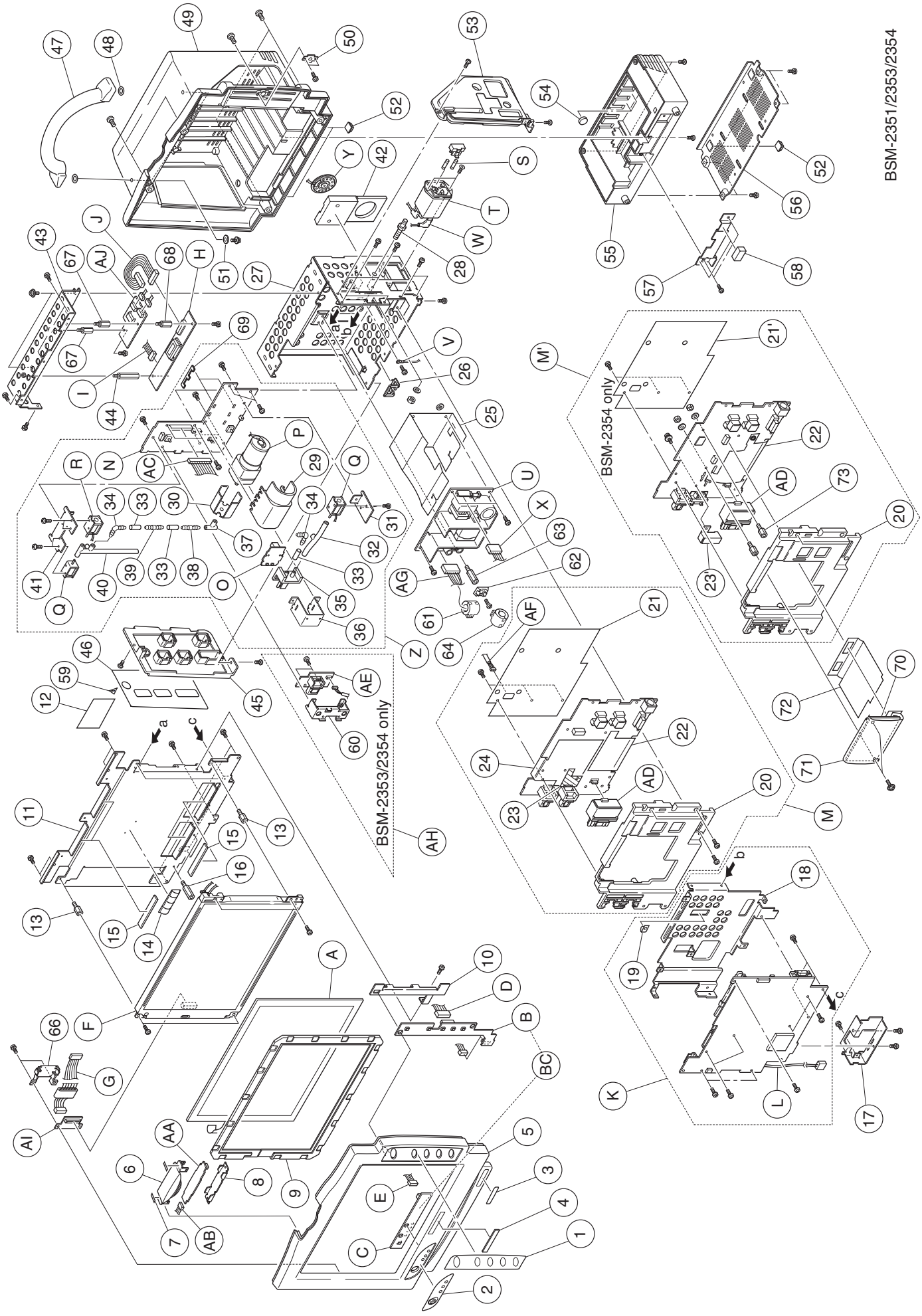
Index	NK Code No.	Qty	Description	
37	6114-115137	1	Plastic tee tube	
38	531346	1	Air filter	ﾎﾟﾝﾌﾟ吸気ﾌｨﾙﾀ
39	531355	1	Check valve	逆止弁
40	6113-039854A	1	NIBP main tube S	
41	6114-114646C	1	Valve holder 2	
42	6113-037125	1	Speaker holder	ｽﾋﾟｰｶﾎﾙﾀﾞ
43	6113-051332A	1	Inverter and Inverter IF board holder	上部ｼｬｰｼ
44	128381	1	Spacer bolt for Inverter board	ｲﾝﾊﾞｰﾀ取り付け用
45	6112-16925A	1	Left side input panel for BSM-2351/2353	左側(入力部)ﾍﾞｾﾞﾙ
45	6112-016925A	1	Left side input panel for BSM-2354	左側(入力部)ﾍﾞｾﾞﾙ
46	6123-014523	1	Input panel sheet for BSM-2351	左側ﾊﾟﾈﾙBSM-2351
46	6123-012971	1	Input panel sheet for BSM-2353	左側ﾊﾟﾈﾙBSM-2353
46	6123-014559	1	Input panel sheet for BSM-2354	左側ﾊﾟﾈﾙBSM-2354
47	6111-06305C	1	Handle	取っ手
48	315357A	2	O-ring	Oﾘﾝｸﾞ P10(ｱｶｼﾘｺﾝ)
49	6111-08134A	1	Rear enclosure	ﾘｱｴﾝｸﾛｰｼﾞｬ
50	6114-118054	1	Screwed plate	
51	6114-15663A	2	Washer for handle	
52	518272	4	Square rubber foot	ｺﾞﾑ足
53	6112-014767C	1	Right side panel	右側ﾍﾞｾﾞﾙ
54	611893	3	Battery cushion sponge	ﾊﾞｯﾃﾘ押さえｽﾎﾟﾝｼﾞ
55	6111-006297C	1	Battery enclosure	ﾊﾞｯﾃﾘｴﾝｸﾛｰｼﾞｬ
56	6113-039916C	1	Bottom plate	下部板金(底板)
57	6114-117795A	1	Ground plate	本体ｸﾞﾗｳﾝﾄﾞ結合用
58	6114-120915	1	Conductive gasket	ｶﾞｽｹｯﾄ
59	1124-037173B	1	High voltage warning label	高圧注意ﾗﾍﾞﾙ
60	6113-044144*1*2	1	IBP board holder	
61	442095A	1	Ferrite core between MAIN board and power supply unit	ﾒｲﾝｰ 電源間ﾌｪﾗｲﾄ
62	619983	1	Ferrite core fitting	ﾌｪﾗｲﾄｺｱ固定具
63	128345	1	Spacer bolt for ferrite core fitting	ﾌｪﾗｲﾄｺｱ取り付け用ﾎﾞﾙﾄ
64	488508A	1	Ferrite core between NIBP and MAIN boards	NIBPﾌｪﾗｲﾄ
66	6114-136738	1	Ferrite core holder	LCDｹｰﾌﾞﾙ押さえ金具
67	127952	2	Spacer bolt for Inverter IF board	ｲﾝﾊﾞｰﾀIFﾎﾞｰﾄﾞ取り付け用
68	127925	1	Spacer bolt for Inverter board	ｲﾝﾊﾞｰﾀ取り付け用
69	6114-131066	2	Rubber lock	
70	634814	1	MP506 Oximax pulse oximetry module	
71	6190-014148	1	Nellcor shield	
72	6114-128845	1	Nellcor insulation sheet	
73	127925	3	Spacer bolt for UR-3712	ｶﾝｶｸﾎﾞﾙﾄ
A	674922	1	Touch screen	ﾀｯﾁﾊﾟﾈﾙ
AA	UR-3611	1	Alarm indicator board	ｱﾗｰﾑｲﾝｼﾞｹｰﾀﾎﾞｰﾄﾞ
AB	613231A	1	Alarm indicator board cable	ｱﾗｰﾑｲﾝｼﾞｹｰﾀｹｰﾌﾞﾙ
AC	613249A	1	Cable between NIBP and MAIN boards	NIBPﾎﾞｰﾄﾞｰﾒｲﾝﾎﾞｰﾄﾞ間ｹｰﾌﾞﾙ
AD	515756C	1	ECG input socket	ECGｺﾈｸﾀ
AE	------	1	IBP board	

*1 For BSM-2353 *2 For BSM-2354A


BSM-2351/2353/2354
BSM-2354 only
BSM-2353/2354 only

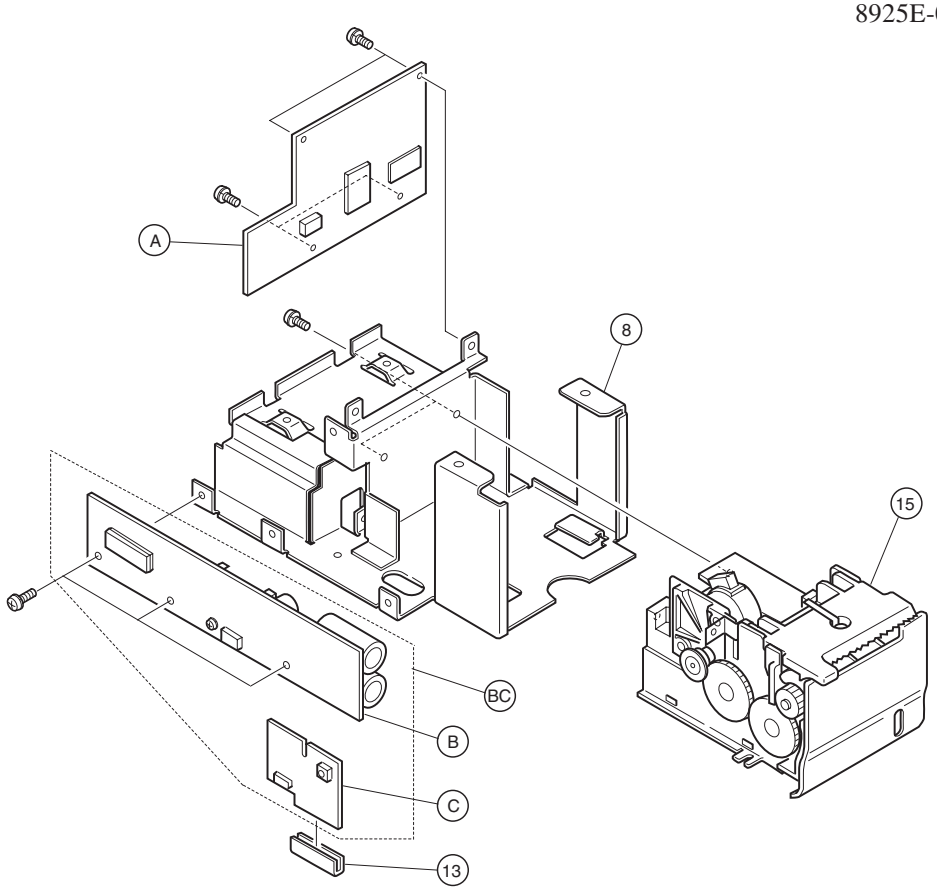
Index	NK Code No.	Qty	Description	
AF	628777*1	1	Cable between Analog and IBP boards	ANALOGﾎﾞｰﾄﾞｰIBP ﾎﾞｰﾄﾞ 間ｹｰﾌﾞﾙ
AF	692181A*2	1	Cable between Analog and IBP boards	ANALOGボー ドｰIBP ボー ド間ｹｰﾌﾞﾙ
AG	613187A	1	15 V DC supply harness	ﾊﾟﾜｰｹｰﾌﾞﾙ
AH	UR-3681*1	1	IBP board (holder included)	
AH	UR-3876*2	1	IBP board (holder included)	
AI	UR-3838	1	LCD IF board	LCD IFﾎﾞｰﾄﾞ
AJ	UR-3839	1	Inverter IF board	ｲﾝﾊﾞｰﾀIFﾎﾞｰﾄﾞ
B	------	1	Operation board	操作ﾎﾞｰﾄﾞ
BC	UR-3841	1	Operation & Power SW boards	
C	------	1	Power SW board	ﾊﾟﾜｰｽｲｯﾁﾎﾞｰﾄﾞ
D	613213A	1	Cable between Operation and MAIN boards	ｿｳｻﾌﾞｹｰﾌﾞﾙ
E	613222A	1	Cable between Operation and Power SW boards	ﾊﾟﾜｰｽｲｯﾁｹｰﾌﾞﾙ
F	671506	1	LCD unit	LCDﾕﾆｯﾄ
G	674717	1	Cable between LCD IF and MAIN boards (Ferrite core included)	LCDﾃﾞｼﾞﾀﾙﾃﾞｰﾀｹｰﾌﾞﾙ
H	539463	1	Inverter board	ｲﾝﾊﾞｰﾀﾎﾞｰﾄﾞ
I	613151A	1	Cable between MAIN and Inverter boards	ｲﾝﾊﾞｰﾀｹｰﾌﾞﾙ
J	674726	1	Cable between Inverter and Inverter IF boards	ﾊﾞｯｸﾗｲﾄﾖｳｹｰﾌﾞﾙ
K	UR-3840	1	MAIN board (This shield cover and battery cable are included.)	ﾒｲﾝﾎﾞｰﾄﾞ
L	613828A	1	Rechargeable battery connection cable	ﾊﾞｯﾃﾘｹｰﾌﾞﾙ
M	UR-36121	1	Analog board for BSM-2351/2353 (The plastic cover, insulation sheet and three shield sheets are included.)	ｱﾅﾛｸﾞﾎﾞｰﾄﾞ
M’	UR-3875	1	Analog board for BSM-2354A (The plastic cover, insulation sheet and three shield sheets are included.)	ｱﾅﾛｸﾞﾎﾞｰﾄﾞ
N	------	1	NIBP board	NIBPﾎﾞｰﾄﾞ
O	------	1	Hall Sensor board	ｶﾌ･ﾎｰｽ認識用ｾﾝｻﾎﾞｰﾄﾞ
P	532149	1	NIBP pump	ﾎﾟﾝﾌﾟ
Q	622364	2	Solenoid valve	電磁弁
R	611394A	1	Solenoid valve	電磁弁
S	104522	2	2A fuse	ﾋｭｰｽﾞ
T	580676	1	AC inlet socket with fuse drawer	ACｲﾝﾚｯﾄ
	or the following combination			
	550067	1	AC inlet socket	ACｲﾝﾚｯﾄ
	550076	1	Fuse drawer	ﾋｭｰｽﾞﾎﾙﾀﾞ
U	550013B	1	Power supply unit	電源ﾕﾆｯﾄ
V	613169B	1	Ground wire	
W	613169A	1	Wires between AC inlet socket and power supply unit	ﾋﾗｶﾞﾀｰﾏﾙｶﾞﾀｹｰﾌﾞﾙ
X	628919A	1	AC power harness	ACｹｰﾌﾞﾙ
Y	613267B	1	Speaker	ｽﾋﾟｰｶ
Z	UR-3643	1	NIBP & Hall Sensor boards (The components such as pump, valves and tubes are included.)	ﾎﾟﾝﾌﾟ, ﾊﾞﾙﾌﾞ, ｺﾈｸﾀ, 配管付き
Z	UR-3880*2	1	NIBP & Hall Sensor boards (The components such as pump, valves and tubes are included.)	ﾎﾟﾝﾌﾟ, ﾊﾞﾙﾌﾞ, ｺﾈｸﾀ, 配管付き

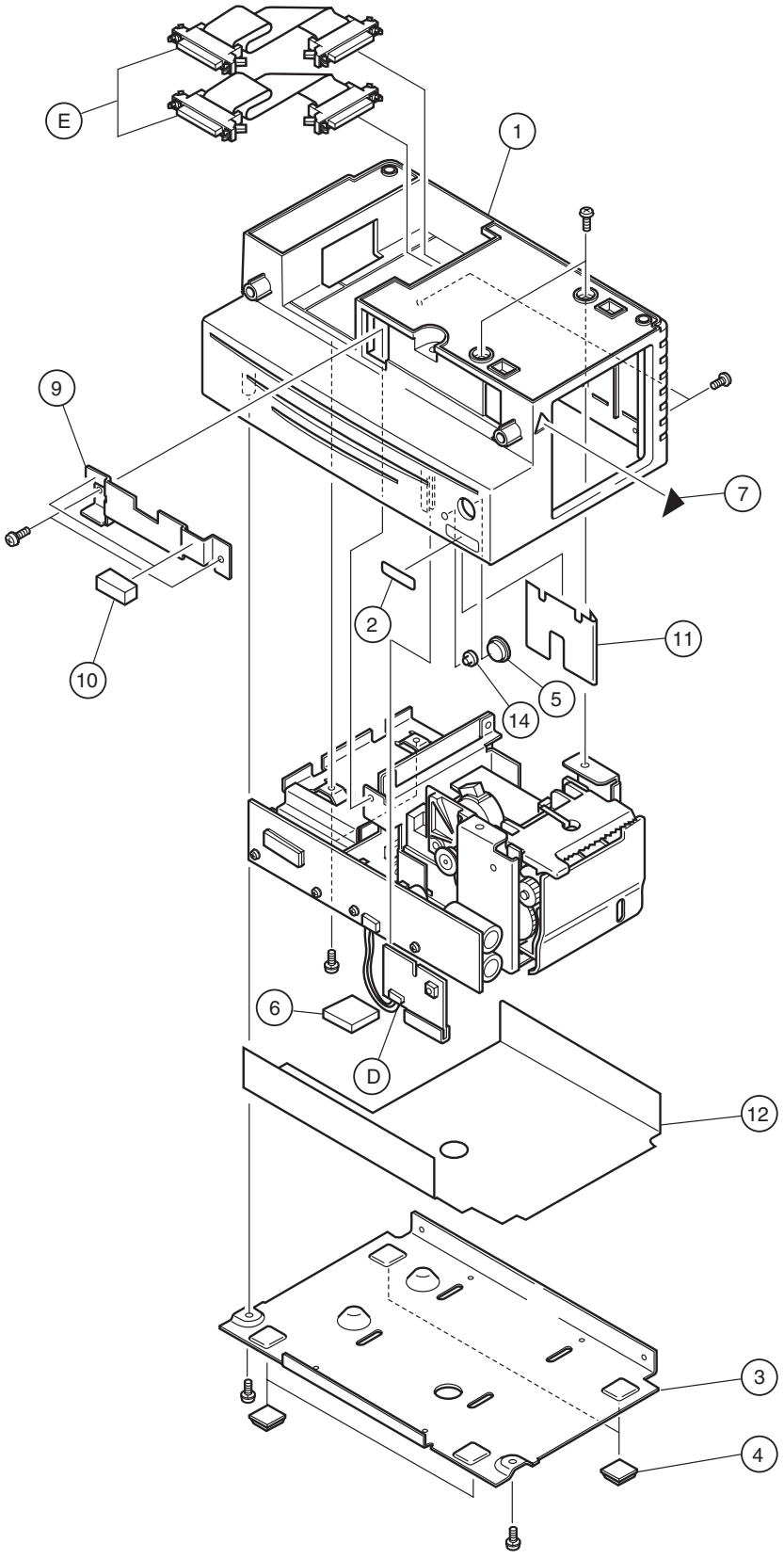
*1 For BSM-2353 *2 For BSM-2354A


BSM-2351/2353/2354
BSM-2354 only
BSM-2353/2354 only

Optional Recorder Module WS-231P

Index	NK Code No.	Qty	Description	
1	6111-006288C	1	Recorder enclosure	レコーダエンクロージャ
2	6124-033492A	1	Model number label	WS-231P型式ラベル
3	6112-014731C	1	Recorder bottom plate	下部板金（底板）
4	518272	4	Square rubber foot	ゴム足バンポンTM166-8
5	6114-120336	1	Key top cover	キートップφ10.5 (K-721)
6	6114-120416	1	Battery cushion sponge	バッテリ押さえスポンジ
7	6114-120425	1	Triangle mark label	マガジン開閉三角マーク
8	6142-002714C	1	Recorder chassis	内部フレーム
9	6114-117795A	1	Ground plate	本体グランド結合用
10	6114-120915	2	Gasket	本体ｸﾞﾗﾝﾄﾞ結合用ｶﾞｽｹｯﾄL16
11	6114-225654B	1	Switch insulation sheet	
12	6113-040166C	1	Recorder insulation sheet	
13	6114-104096	1	Board edge cover	ソフトエッジ27
14	6114-115877B	1	LED filter	
15	RG-922P	1	Recorder unit	搬送部
A	UR-3615	1	REC MAIN board	
B	------	1	REC Power board	
BC	UR-3616	1	REC Key & Power Boards	
C	------	1	REC Key board	
D	526931	1	Cable between the REC Power and Key boards	ケーブル 51021-0500 L=55MM リョウタン
E	613204A	2	Flat cable	ケーブル 8925E-040-179-018-GGﾌｪﾗｲﾄ

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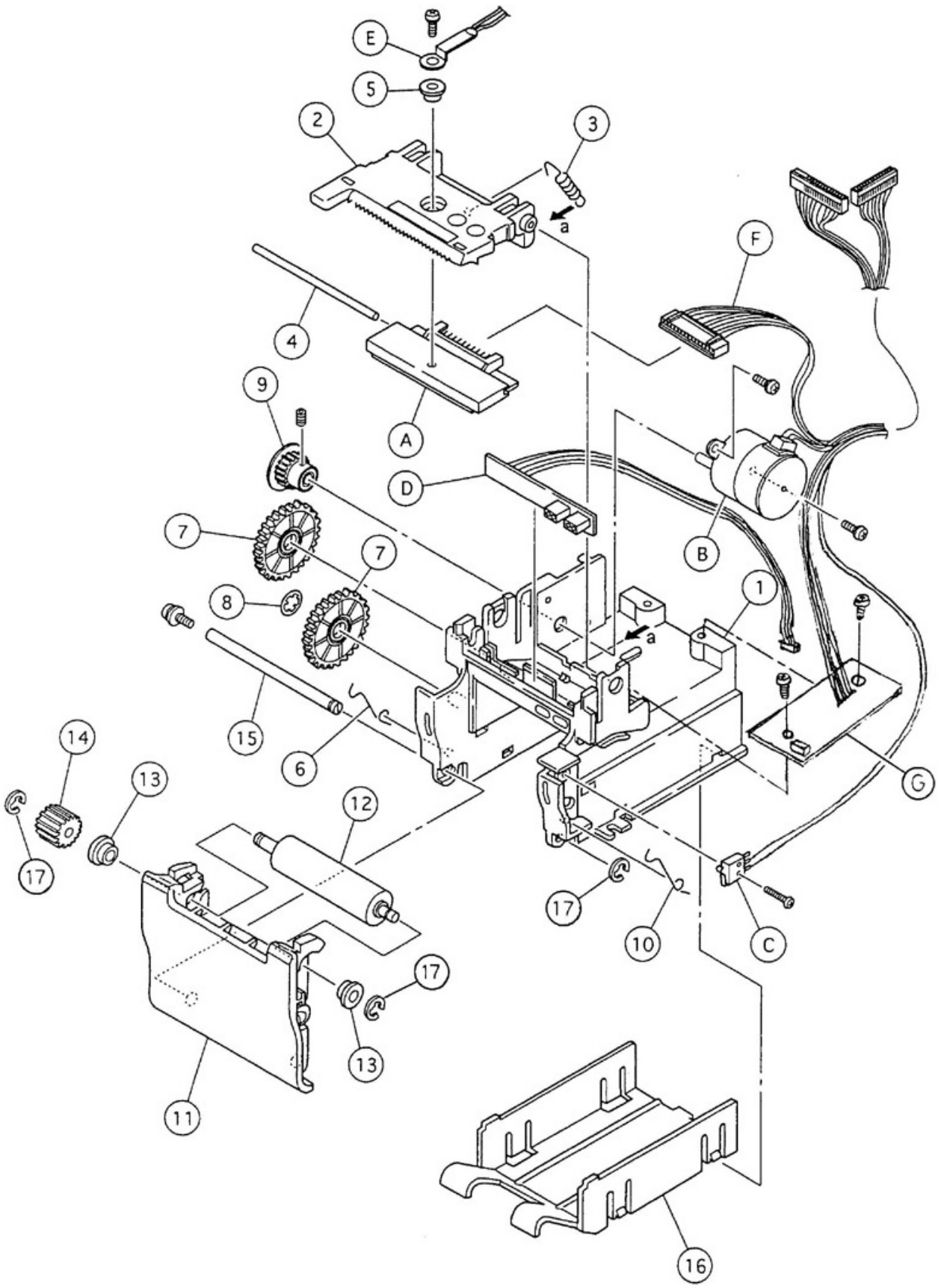
RG-922P Recorder Unit

Index	NK Code No.	Qty	Description	
1	6111-002327E	1	Recorder drive unit chassis	キダイ
2	6113-017726C	1	Head holder	ヘッドオサエ
3	6114-067901A	1	Spring for head	K280 ヘッドカアツバネ
4	6114-053132A	1	Shaft for head	サーマルヘッドジグ
5	515284	1	Bearing for head	B-F3-27 ベアリング
6	6114-053141B	1	Spring for magazine door (left)	マガジンオシバネヒダリ
7	6114-053177C	2	Idle gear	チュウケイハグルマ
8	515506A	1	Stopper ring	CA-5 トメワ
9	6114-053168C	1	Driving gear	モータハグルマ
10	6114-053159B	1	Spring for magazine door (right)	マガジンオシバネミギ
11	6112-008444C	1	Magazine door	オリタタミシヨウマガジン
12	6114-053114C	1	Platen roller	プラテンローラ
13	492503	2	Bearing for magazine door	R-BRF0404 スリーブベアリング
14	6114-059474B	1	Gear for platen roller	プラテンハグルマ
15	6114-053186A	1	Shaft for magazine door	マガジンコテイジグ
16	6113-023951A	1	Magazine tray	オリタタミシヨウソコイタ
17	107002	3	Retainer ring	E-32 リテナリング
A	445074	1	Thermal array head	サーマルヘッド RJ048-8S81
B	445109B	1	Paper drive motor	搬送用モータ PFC25-48T1 G (1/20)-01
C	448053	1	Micro switch	マイクロスイッチ AV404461
D	UR-3570	1	Sensor board	センサボード
	578447	2	LED and photo transistor assembly	フォトセンサ
E	614328	1	Thermal array head grounding lead	ｻｰﾏﾙﾍｯﾄﾞ接地ｹｰﾌﾞﾙ
F	449132	1	Thermal array head connection cable	ｻｰﾏﾙﾍｯﾄﾞ接続ｹｰﾌﾞﾙ PHR-15
G	UR-3571	1	Sensor control board	ボリュームボード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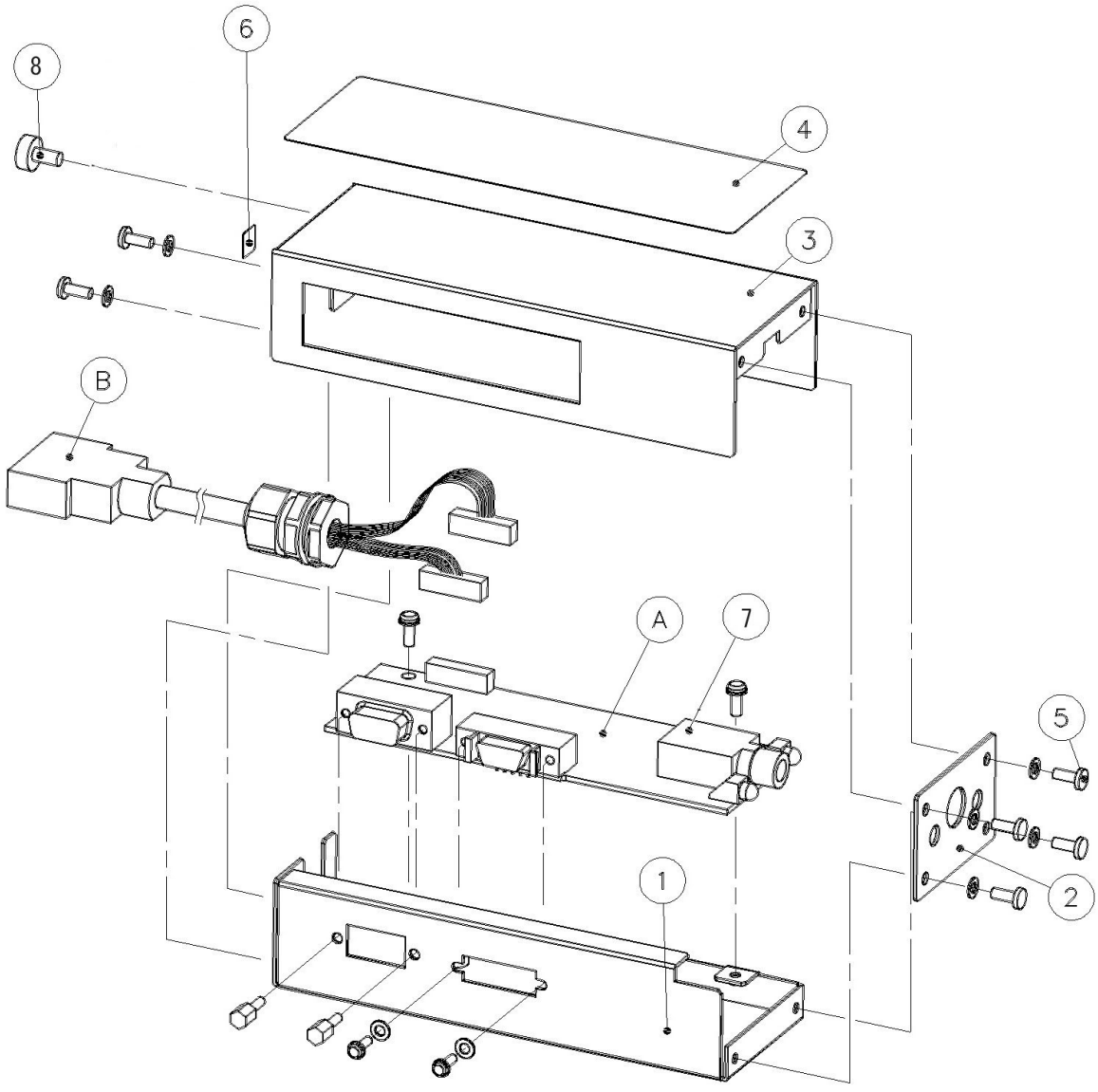
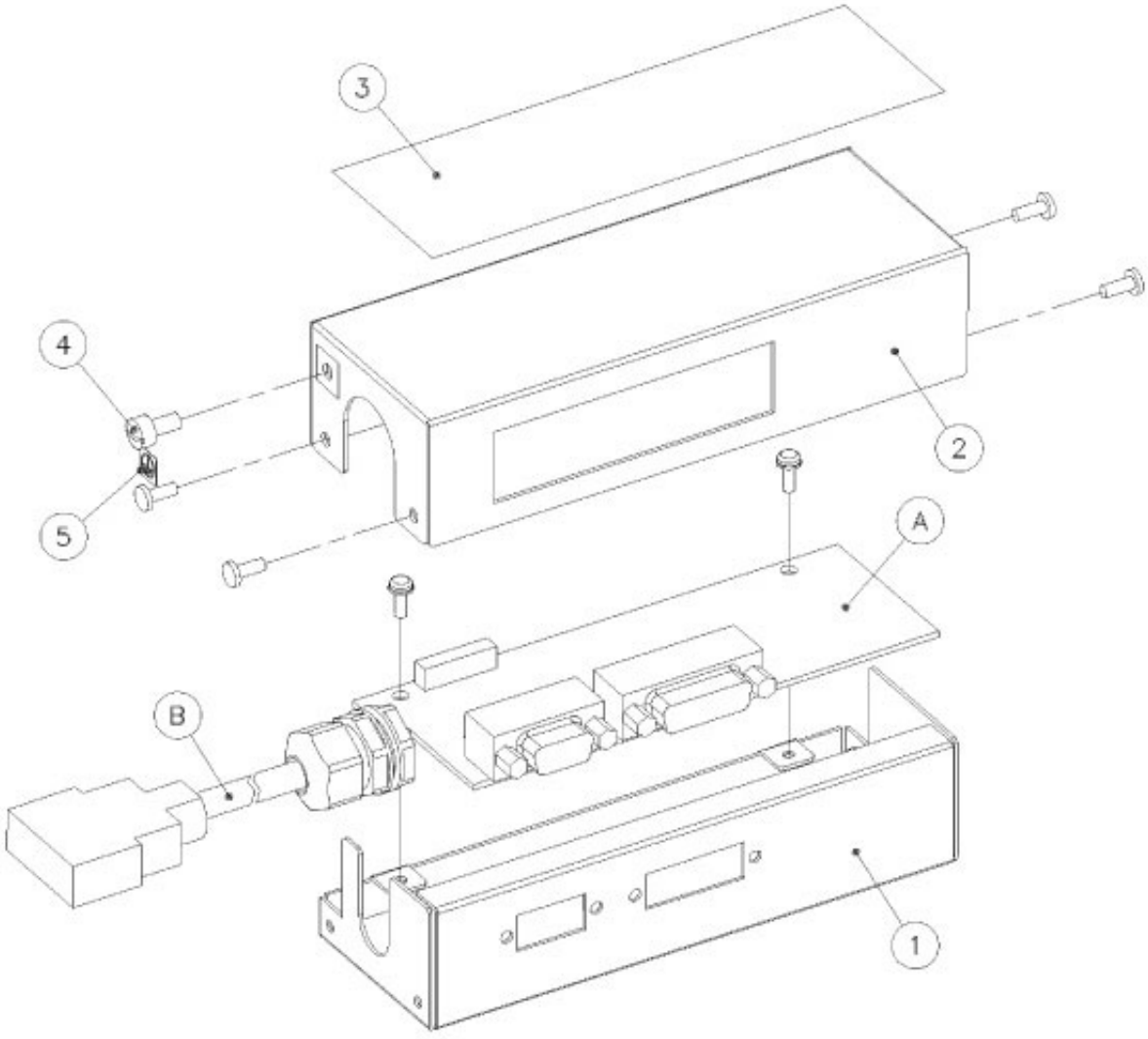
QI-231P Interface

Index	NK Code No.	Qty	Description	
1	6113-045214	1	Bottom case	ボトムプレートXI
2	6114-125875A	1	Side panel	サイドパネル
3	6113-045205A	1	Top cover	トップ—カバーXI
4	6123-014006	1	WARNING label	QI-231P警告パネル
5	123225	6	Black screw	ϕ3x8 ネジ
6	6124-035614	1	Protective earth symbol label	ﾎｺﾞｾｯﾁﾏｰｸﾗﾍﾞﾙ
7	094497	1	TRIG/ECG output jack	TRIG/ECG コネクタ
8	6114-126776	1	Protective earth screw	EARTH ネジ
A	UR-3691	1	IO ANALOG OUT board	
B	625904A	1	AUX connection cable	モニタ接続ケーブル



QI-236P Interface

Index	NK Code No.	Qty	Description	
1	6113-047417	1	Bottom case	BOTTOM PLATE
2	6113-047408	1	Top cover	TOP COVER
3	6123-015415	1	Warning label	QI-236P WARNING PANEL
4	6114-126776	4	Protective earth screw	EARTHﾈｼﾞ
5	6124-035614	1	Protective earth symbol label	ﾎｺﾞ ｾｯﾁﾏｰｸﾗﾍﾞﾙ
A	UR-3731	1	IO CT OUT board	IO_CT_OUT BOARD
B	643724	1	AUX connection cable	DX30AM/PHR10,9(W440)ﾄｸ



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Section 9 Connector Pin Assignment

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CN0202 (for CN101 on Operation board) 9.1
CN0204 (for CN001 on REC MAIN board of optional recorder module) 9.2
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IO CT OUT Board 9.25
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CN003 ..... 9.25

MAIN Board

CN0201 (for Alarm Indicator board)

Pin Number	Signal Name	Signal Description
1	+15V	+15 V supply voltage
2	RED	Red LED cluster control
3	YELLOW	Yellow LED cluster control
4	GREEN	Green LED cluster control

CN0202 (for CN101 on Operation board)

Pin Number	Signal Name	Signal Description
1	ALM_SS	SILENCE ALARMS key
2	MENU	MENU key
3	HOME	HOME key
4	NBP_SS	NIBP START/STOP key
5	NBP_IT	NIBP INTERVAL key
6	E2	Digital ground
7	E2	Digital ground
8	E2	Digital ground
9	E2	Digital ground
10	POWER_KEY	Power switch
11	LED_BATCHG	Battery charging lamp
12	LED_BATOP	Battery power lamp
13	LED_STBY	AC power lamp
14	+5V	+5 V supply voltage
15	+15V	+15 V supply voltage

CN0204 (for CN001 on REC MAIN board of optional recorder module)

Signal Description	Signal Name	Pin Number		Signal Name	Signal Description
Digital ground	E2	1	2	A1	Address bit 1
Address bit 2	A2	3	4	A3	Address bit 3
Address bit 4	A4	5	6	A5	Address bit 5
Digital ground	E2	7	8	A6	Address bit 6
Address bit 7	A7	9	10	A8	Address bit 8
Address bit 9	A9	11	12	E2	Digital ground
Data bit 0	D0	13	14	D1	Data bit 1
Data bit 2	D2	15	16	D3	Data bit 3
Digital ground	E2	17	18	D4	Data bit 4
Data bit 5	D5	19	20	D6	Data bit 6
Data bit 7	D7	21	22	E2	Digital ground
Digital ground	E2	23	24	MOP_5	Paper magazine status signal
Out of paper lamp	PAP_LED	25	26	+3.3V	+3.3 V supply voltage
+5 V supply voltage	+5V	27	28	+15V	+15 V supply voltage
+15 V supply voltage	+15V	29	30	KEY8	Interval key
Digital ground	E2	31	32	ACCD0	Option status 0 signal
Chip select signal	X80SL	33	34	XPWRRST	Power reset
Digital ground	E2	35	36	RXW	Read/Write control signal
System reset	XSYSRST	37	38	XDTACK	Data acknowledge
Recorder interrupt request	INTREC	39	40	E2	Digital ground

CN0205 (for CN002 on REC MAIN board of optional recorder module)

Signal Description	Signal Name	Pin Number		Signal Name	Signal Description
Digital ground	E2	1	2	A10	Address bit 10
Address bit 11	A11	3	4	A12	Address bit 12
Address bit 13	A13	5	6	A14	Address bit 14
Digital ground	E2	7	8	A15	Address bit 15
Address bit 16	A16	9	10	A17	Address bit 17
Address bit 18	A18	11	12	E2	Digital ground
Data bit 8	D8	13	14	D9	Data bit 9
Data bit 10	D10	15	16	D11	Data bit 11
Digital ground	E2	17	18	D12	Data bit 12
Data bit 13	D13	19	20	D14	Data bit 14
Data bit 15	D15	21	22	E2	Digital ground
Digital ground	E2	23	24	PEMP_5	Paper status signal
Not connected	NC	25	26	+3.3V	+3.3 V supply voltage
+5 V supply voltage	+5V	27	28	+15V	+15 V supply voltage
+15 V supply voltage	+15V	29	30	K3	Record key
Digital ground	E2	31	32	ACCD1	Option status 1 signal
Recorder reset	XRESWS	33	34	XRSTPRO	Program reset
Digital ground	E2	35	36	PRTREQ	Record request
Paper/mark detection signal	SNSON	37	38	24VOK	+24 V status signal
Recorder module connection signal	EXTWS	39	40	E2	Digital ground

CN401 (for power supply unit)

Pin Number	Signal Name	Signal Description
1	VOTS	+15 V supply voltage
2	VOTS	+15 V supply voltage
3	VOTS	+15 V supply voltage
4	E2	Digital ground
5	E2	Digital ground
6	E2	Digital ground

CN0601 (for program card or network card)

Signal Description	Signal Name	Pin Number		Signal Name	Signal Description
Digital ground	E2	1	2	MEMD3	Memory card data bit 3
Memory card data bit 4	MEMD4	3	4	MEMD5	Memory card data bit 5
Memory card data bit 6	MEMD6	5	6	MEMD7	Memory card data bit 7
Memory card chip enable 1	XMEMCE1	7	8	MEMA10	Memory card address bit 10
Memory card output enable	XMOE	9	10	MEMA11	Memory card address bit 11
Memory card address bit 9	MEMA9	11	12	MEMA8	Memory card address bit 8
Memory card address bit 13	MEMA13	13	14	MEMA14	Memory card address bit 14
Memory card write enable	XMWE	15	16	XMCBSY	Memory card busy
+5 V supply voltage	+5V	17	18	+5V	+5 V supply voltage
Memory card address bit 16	MEMA16	19	20	MEMA15	Memory card address bit 15
Memory card address bit 12	MEMA12	21	22	MEMA7	Memory card address bit 7
Memory card address bit 6	MEMA6	23	24	MEMA5	Memory card address bit 5
Memory card address bit 4	MEMA4	25	26	MEMA3	Memory card address bit 3
Memory card address bit 2	MEMA2	27	28	MEMA1	Memory card address bit 1
Digital ground	E2	29	30	MEMD0	Memory card data bit 0
Memory card data bit 1	MEMD1	31	32	MEMD2	Memory card data bit 2
Memory card write protect	MCWP	33	34	E2	Digital ground
Digital ground	E2	35	36	XMCD1	Memory card detect bit 1
Memory card data bit 11	MEMD11	37	38	MEMD12	Memory card data bit 12
Memory card data bit 13	MEMD13	39	40	MEMD14	Memory card data bit 14
Memory card data bit 15	MEMD15	41	42	XMEMCE2	Memory card chip enable 2
Not connected	NC	43	44	NC	Not connected
Not connected	NC	45	46	MEMA17	Memory card address bit 17
Memory card address bit 18	MEMA18	47	48	BANK0	Memory bank select bit 0
Memory bank select bit 1	BANK1	49	50	BANK2	Memory bank select bit 2
+5 V supply voltage	+5V	51	52	+5V	+5 V supply voltage
Memory bank select bit 3	BANK3	53	54	BANK4	Memory bank select bit 4
Memory bank select bit 5	BANK5	55	56	BANK6	Memory bank select bit 6
Not connected	NC	57	58	XMRST	Memory card reset
Not connected	NC	59	60	NC	Not connected
Attribute/common memory select	XREG	61	62	XMCBAT2	Memory card battery status bit 2
Memory card battery status bit 1	XMCBAT1	63	64	MEMD8	Memory card data bit 8
Memory card data bit 9	MEMD9	65	66	MEMD10	Memory card data bit 10
Memory card detect bit 2	XMCD2	67	68	E2	Digital ground

CN0701 (for touch screen)

Pin Number	Signal Name	Signal Description
1	NC	Not connected
2	TOUCH_U	Touch screen U signal
3	NC	Not connected
4	TOUCH_R	Touch screen R signal
5	NC	Not connected
6	TOUCH_A	Touch screen A signal
7	NC	Not connected
8	TOUCH_L	Touch screen L signal
9	NC	Not connected
10	TOUCH_B	Touch screen B signal
11	NC	Not connected
12	TOUCH_D	Touch screen D signal
13	NC	Not connected
14	TOUCH_C	Touch screen C signal
15	NC	Not connected

CN0801 (AUX socket)

Signal Description	Signal Name	Pin Number		Signal Name	Signal Description
Red output	RED	1	11	RRET	Red output return
Green output	GREEN	2	12	GRET	Green output return
Blue output	BLUE	3	13	BRET	Blue output return
Vertical synchronous signal	VSYNC	4	14	E2	Digital ground
Horizontal synchronous signal	HSYNC	5	15	E2	Digital ground
Inhibit (Reserve 01)	RESV01	6	16	+5V	+5 V supply voltage
Inhibit (Reserve 02)	RESV02	7	17	E2	Digital ground
Data Transmit (RS232C)	RSTXD	8	18	RSRXD	Data Receive (RS232C)
Request to Send (RS232C)	XRSRTS	9	19	XRSCTS	Clear to Send (RS232C)
Data Set Ready (RS232C)	XRSCD	10	20	XRSDTR	Data Termination Ready (RS232C)

CN0802 (for Inverter board)

Pin Number	Signal Name	Signal Description
1	+15V	+15 V supply voltage for backlight
2	+15V	+15 V supply voltage for backlight
3	E2	Digital ground
4	E2	Digital ground
5	BCNT	Backlight ON/OFF control
6	BCNT_PWM	Brightness control
7	NC	Not connected
8	NC	Not connected
9	NC	Not connected
10	NC	Not connected

CN1001 (for LCD unit)

Pin Number	Signal Name	Signal Description
1	E2	Digital ground
2	+3.3V	+3.3 V supply voltage
3	+3.3V	+3.3 V supply voltage
4	E2	Digital ground
5	LCDENB	LCD enable signal
6	LCD_B2	LCD blue 5
7	LCD_B1	LCD blue 4
8	LCD_B0	LCD blue 3
9	LCD_B2	LCD blue 2
10	LCD_B1	LCD blue 1
11	LCD_B0	LCD blue 0
12	E2	Digital ground
13	LCD_G2	LCD green 5
14	LCD_G1	LCD green 4
15	LCD_G0	LCD green 3
16	LCD_G2	LCD green 2
17	LCD_G1	LCD green 1
18	LCD_G0	LCD green 0
19	E2	Digital ground
20	LCD_R2	LCD red 5
21	LCD_R1	LCD red 4
22	LCD_R0	LCD red 3
23	LCD_R2	LCD red 2
24	LCD_R1	LCD red 1
25	LCD_R0	LCD red 0
26	E2	Digital ground
27	N.C.	Not connected
28	N.C.	Not connected
29	DCLK	LCD dot clock
30	E2	Digital ground

CN1401 (for rechargeable battery pack)

Pin Number	Signal Name	Signal Description
1	VBAT	Battery output voltage
2	E2	Ground
3	EDET	Battery pack detection signal
4	Th	Thermistor output signal

CN1501 (for CN901 on Analog board)

Signal Description	Signal Name	Pin Number		Signal Name	Signal Description
ERC reset	XRST_ECG	1	2	TXD_ECG	ECG serial communication (Transmit)
ECG serial communication (Receive)	RXD_ECG	3	4	FCLK	Clock for floating power
+15 V supply voltage	+15V	5	6	+15V	+15 V supply voltage
+15 V supply voltage	+15V	7	8	+5V	+5 V supply voltage
+5 V supply voltage	+5V	9	10	+5V	+5 V supply voltage
Digital ground	E2	11	12	E2	Digital ground
Digital ground	E2	13	14	E2	Digital ground
Digital ground	E2	15	16	E2	Digital ground
Digital ground	E2	17	18	XRST_H8A	APU reset
APU mode select signal	MODE_H8A	19	20	TXD_SPO2	SpO2 serial communication (Transmit)
SpO2 serial communication (Receive)	RXD_SPO2	21	22	RXD_MP	MP serial communication (Receive)
Board status 0	DPUSEL0	23	24	DPUSEL1	Board status 1
ZB respiration signal	ZB_RESP	25	26	ZB_CNFM	ZB recognition signal
ZB initialize signal	ZB_INIT	27	28	ZB_RST	ZB reset
ZB serial communication (Receive)	RXD_ZB	29	30	TXD_ZB	ZB serial communication (Transmit)

CN1502 (for CN0101 on NIBP board)

Signal Description	Signal Name	Pin Number		Signal Name	Signal Description
CUFF 0 return	CUFF0_RET	1	2	CUFF1_RET	CUFF 1 return
Over pressure error	OVER_PRES	3	4	TIME_OUT	Time out error
Inflation interval error	SHORT_REST	5	6	INT_RET	INTERVAL return
Zeroing signal	ZERO	7	8	INST1	Instantaneous recovery 1
Instantaneous recovery 2	INST2	9	10	GAIN	Gain select
Periodic measurement interval	INTERVAL	11	12	CUFF0	Measurement mode 0
Measurement mode 1	CUFF1	13	14	BRAKE	Pump brake
Pump control	PUMP	15	16	VALVE3	Valve 3 control
Valve 2 control	VALVE2	17	18	VALVE1	Valve 1 control
A to D control	AD_TXD	19	20	AD_RXD	A to D data receive
A to D control clock	AD_SCK	21	22	XADMP0	A to D channel select 0
A to D channel select 1	XADMP1	23	24	+15V	+15 V supply voltage
Digital ground	E2	25	26	+15V	+15 V supply voltage
Digital ground	E2	27	28	E2	Digital ground
Digital ground	E2	29	30	E2	Digital ground
Line frequency detection (+)	FREQ+	31	32	FREQ–	Line frequency detection (–)
Speaker sound (+)	SND+	33	34	SND–	Speaker sound (–)

Alarm Indicator Board

CN0101 (for CN0201 on MAIN board)

Refer to “CN0201 (for Alarm Indicator board)” in the “MAIN Board” section.

Analog Board

CN502

Pin Number	Signal Name	Signal Description
1	DETECTOR (+)	
2	DIGITAL GND	
3	DIGITAL SIGNAL	
4	DETECTOR (–)	
5	INNER SHIELD	
6	N.C.	
7	LED (–)	
8	N.C.	
9	LED (+)	
10	OUTER SHIELD	

CN601 (for CN001 on IBP board)

Pin Number	Signal Name	Signal Description
1	XIO2	IBP board identification
2	IBP2	Blood pressure waveform
3	AEF	Analog ground
4	–5VAF	–5 V supply voltage
5	IBP2_CHK	Detection of transducer wire break
6	ROM_CLK2	Clock for ROM in connector of connection cord
7	ROM_DATA2	Data for ROM in connector of connection cord
8	SW_2	Zero balance switch
9	+6VF	+6 V supply voltage
10	AEF	Analog ground

CN602

Pin Number	Signal Name	Signal Description
1	N.C.	
2	AEF	
3	AEF	
4	XNELL_RST	
5	AEF	
6	N.C.	
7	–5VAF	
8	Rx_4	
9	Tx_4	
10	+5VSPO	
11	AEF	
12	AEF	
13	+5VDF	
14	AEF	

CN901 (for CN1501 on MAIN board)

Refer to “CN1501 (for CN901 on Analog board)” in the “MAIN Board” section.

CN902 (for ZB-900P transmitter)

Pin Number	Signal Name	Signal Description
1	ZB_RESP	ZB respiration signal
2	DGND	Digital ground
3	ZB_CNFM	ZB recognition signal
4	+5V	+5 V supply voltage
5	ZB_XRST	ZB reset signal
6	ZB_XINIT	ZB initialize signal
7	ZB_XTXD	ZB serial communication (Transmit)
8	ZB_XRXD	ZB serial communication (Receive)

NIBP Board

CN0101 (for CN1502 on MAIN board)

Refer to “CN1502 (for CN0101 on NIBP board)” in the “MAIN Board” section.

CN0102 (for Hall Sensor board)

Pin Number	Signal Name	Signal Description
1	+5V	+5 V supply voltage
2	+5V	+5 V supply voltage
3	CUFF0	Measurement mode 0
4	CUFF1	Measurement mode 1
5	E2	Digital ground
6	E2	Digital ground

CN0103 (for line frequency detection coil wire)

Pin Number	Signal Name	Signal Description
1	FREQ+	Line frequency detection (+)
2	FREQ–	Line frequency detection (–)

CN0104 (for pediatric valve)

Pin Number	Signal Name	Signal Description
1	N.C.	Not connected
2	+6V	+6 V supply voltage
3	VALVE2	Valve 2 control

CN0105 (for safety circiut valve)

Pin Number	Signal Name	Signal Description
1	+6V	+6 V supply voltage
2	VALVE3	Valve 3 control

CN0106 (for pump)

Pin Number	Signal Name	Signal Description
1	+6V	+6 V supply voltage
2	PUMP	Pump control

CN0107 (for speaker)

Pin Number	Signal Name	Signal Description
1	SND+	Speaker sound (+)
2	SND−	Speaker sound (−)
3	N.C.	Not connected
4	N.C.	Not connected

CN0108 (for adult valve)

Pin Number	Signal Name	Signal Description
1	+6V	+6 V supply voltage
2	VALVE1	Valve 1 control

IBP Board

BSM-2301 and BSM-2351 have no IBP board.

CN001 (for CN601 on Analog board)

Pin Number	Signal Name	Signal Description
1	XIO2	IBP board identification
2	IBP2	Blood pressure waveform
3	AEF	Analog ground
4	−5VAF	−5 V supply voltage
5	IBP2_CHK	Detection of transducer wire break
6	ROM_CLK2	Clock for ROM in connector of connection cord
7	ROM_DATA2	Data for ROM in connector of connection cord
8	SW_2	Zero balance switch
9	+6VF	+6 V supply voltage
10	AEF	Analog ground

Operation Board

CN101 (for CN0202 on MAIN board)

Signal Description	Signal Name	Pin Number		Signal Name	Signal Description
SILENCE ALARMS key	XKEY1	1	11	LED_BATCHG	Battery charging LED
MENU key	XKEY4	2	12	LED_BATOP	Battery power LED
HOME key	XKEY5	3	13	LED_STBY	AC power LED
NIBP START/STOP key	XKEY3	4	14	+5V	+5 V supply voltage
NIBP INTERVAL key	XKEY2	5	15	+15V	+15 V supply voltage
Digital ground	E2	6	16		Not connected
Digital ground	E2	7	17		Not connected
Digital ground	E2	8	18		Not connected
Digital ground	E2	9	19		Not connected
Power switch	POWER_KEY	10	20		Not connected

CN102 (for CN103 on Power SW board)

Pin Number	Signal Name	Signal Description
1	+15V	+15 V supply voltage
2	+5V	+5 V supply voltage
3	POWER_KEY	Power switch
4	LED_STBY	AC power LED
5	LED_BATOP	Battery power LED
6	LED_BATCHG	Battery charging LED
7	E2	Digital ground
8	E2	Digital ground
9	E2	Digital ground
10	E2	Digital ground

Power SW Board

CN0103 (for CN102 on Operation board)

Refer to “CN102 (for CN0103 on Power SW board)” in the “Operation Board” section.

Inverter Board

CN1 (for CN0802 on MAIN board)

Pin Number	Signal Name	Signal Description
1	+15V	+15 V supply voltage for backlight
2	+15V	+15 V supply voltage for backlight
3	E2	Digital ground
4	E2	Digital ground
5	CNT	Backlight ON/OFF control
6	VR	Brightness control
7	NC	Not connected
8	NC	Not connected

CN2 (for backlight)

Pin Number	Signal Name	Signal Description
1	Vout-Lo	Low voltage output for backlight (cold cathode tube)
2	NC	Not connected
3	NC	Not connected
4	NC	Not connected
5	Vout-Hi	High voltage output for backlight (cold cathode tube)
6	NC	Not connected
7	Vout-Hi	High voltage output for backlight (cold cathode tube)

Inverter IF Board (for BSM-2351/2353/2354 only)

CN101 (for inverter board)

Pin No.	Signal Name	Signal Description
1	Vout-Lo	Low voltage output for backlight (cold cathode tube)
2	NC	Not connected
3	NC	Not connected
4	NC	Not connected
5	Vout-Hi	High voltage output for backlight (cold cathode tube)
6	NC	Not connected
7	Vout-Hi	High voltage output for backlight (cold cathode tube)

CN102 and CN103 (for backlight lamp)

Pin No.	Signal Name	Signal Description
1	Vout-Hi	High voltage output for backlight (cold cathode tube)
2	Vout-Lo	Low voltage output for backlight (cold cathode tube)

LCD IF Board (for BSM-2351/2353/2354 only)

CN101 (for MAIN board)

Pin No.	Signal Name	Signal Description
1	E2	Digital ground
2	+3.3V	+3.3 V supply voltage
3	+3.3V	+3.3 V supply voltage
4	E2	Digital ground
5	LCDENB	LCD enable signal
6	LCD_B2	LCD blue 5
7	LCD_B1	LCD blue 4
8	LCD_B0	LCD blue 3
9	LCD_B2	LCD blue 2
10	LCD_B1	LCD blue 1
11	LCD_B0	LCD blue 0
12	E2	Digital ground
13	LCD_G2	LCD green 5
14	LCD_G1	LCD green 4
15	LCD_G0	LCD green 3
16	LCD_G2	LCD green 2
17	LCD_G1	LCD green 1
18	LCD_G0	LCD green 0
19	E2	Digital ground
20	LCD_R2	LCD red 5
21	LCD_R1	LCD red 4
22	LCD_R0	LCD red 3
23	LCD_R2	LCD red 2
24	LCD_R1	LCD red 1
25	LCD_R0	LCD red 0
26	E2	Digital ground
27	HSYNC	Horizontal synchronization signal
28	VSYNC	Vertical synchronization signal
29	DCLK	LCD dot clock
30	E2	Digital ground

CN102 (for LCD unit)

Signal Description	Signal Name	Pin No.		Signal Name	Signal Description
Digital ground	E2	1	2	DCLK	LCD dot clock
Digital ground	E2	3	4	HSYNC	Horizontal synchronization signal
Vertical synchronization signal	VSYNC	5	6	E2	Digital ground
Digital ground	E2	7	8	E2	Digital ground
LCD red 0	LCD_R0	9	10	LCD_R1	LCD red 1
LCD red 2	LCD_R2	11	12	E2	Digital ground
LCD red 3	LCD_R0	13	14	LCD_R1	LCD red 4
LCD red 5	LCD_R2	15	16	E2	Digital ground
Digital ground	E2	17	18	E2	Digital ground
LCD green 0	LCD_G0	19	20	LCD_G1	LCD green 1
LCD green 2	LCD_G2	21	22	E2	Digital ground
LCD green 3	LCD_G0	23	24	LCD_G1	LCD green 4
LCD green 5	LCD_G2	25	26	E2	Digital ground
Digital ground	E2	27	28	E2	Digital ground
LCD blue 0	LCD_B0	29	30	LCD_B1	LCD blue 1
LCD blue 2	LCD_B2	31	32	E2	Digital ground
LCD blue 4	LCD_B0	33	34	LCD_B1	LCD blue 4
LCD blue 5	LCD_B2	35	36	E2	Digital ground
LCD enable signal	LCDENB	37	38	R/L	Horizontal display mode
+3.3 V supply voltage	+3.3V	39	40	+3.3V	+3.3 V supply voltage
Vertical display mode	U/D	41	—	—	

Hall Sensor Board

CN101 (for CN102 on NIBP board)

Refer to “CN102 (for CN101 on Hall Sensor board)” in the “NIBP board” section.

REC MAIN Board

CN001 (for CN0204 on MAIN board)

Refer to “CN0204 (for CN001 on REC MAIN board)” in the “MAIN Board” section.

CN002 (for CN0205 on MAIN board)

Refer to “CN0205 (for CN002 on REC MAIN board)” in the “MAIN Board” section.

CN003 (for CN103 on REC Power board)

Signal Description	Signal Name	Pin Number		Signal Name	Signal Description
Motor control	VR 0	1A	1B	Phase 1	Motor phase control
Motor control	VR 1	2A	2B	Phase 0	Motor phase control
Paper/mark sensor enable signal	SNSON	3A	3B	XPEMP	Paper detected signal
Mark detected signal	XPMARK	4A	4B	XMOPEN	Magazine condition detected signal
Record request signal	PRTREQ	5A	5B	24VOK	+24 V status
Digital ground	E2	6A	6B	E2	Digital ground
+3.3 V supply voltage	+3.3V	7A	7B	+5V	+5 V supply voltage
+15 V supply voltage	+15V	8A	8B	+15V	+15 V supply voltage
+15 V supply voltage	+15V	9A	9B	+15V	+15 V supply voltage
Digital ground	E2	10A	10B	E2	Digital ground
Digital ground	E2	11A	11B	E2	Digital ground
Thermal array head data enable signal	XTHEN	12A	12B	XTHSTB	Thermal array head data strobe signal
Thermal array head serial data transfer clock	THCLK	13A	13B	THDAT	Thermal array head serial data
Record key status	KEY3	14A	14B	E2	Digital ground
Out of paper LED indicator	PAP LED	15A	15B	THRM	Thermistor data

REC Key Board

CN201 (for CN104 on REC Power board)

Pin Number	Signal Name	Signal Description
1	+5V	+5 V supply voltage
2	PAP_LED	Out of paper LED
3	KEY_3	Record key
4	E2	Digital ground
5	E2	Digital ground

REC Power Board

CN101 (for recorder unit)

Pin Number	Signal Name	Signal Description
1	MA1	Motor control signal
2	MB1	Motor control signal
3	MA2	Motor control signal
4	MB2	Motor control signal
5	+3.3V	+3.3 V supply voltage
6	MOP_5	Magazine open status
7	+5V	+5 V supply voltage
8	E2	Digital ground
9	SNSON1	Paper detection control
10	PEMP_5	Out of paper status
11	SNSON2	Mark detection control
12	MK_5	Mark detection status

CN102 (for recorder unit)

Pin Number	Signal Name	Signal Description
1	+24V	+24 V supply voltage for thermal array head
2	+24V	+24 V supply voltage for thermal array head
3	E24	+24 V ground return
4	E24	+24 V ground return
5	+5V	+5 V supply voltage
6	THM_5	Thermistor data
7	NTHENB	Thermal array head enable signal
8	NTHENB	Thermal array head enable signal
9	THCLK	Serial data transfer clock
10	NTHSTB	Thermal array head data strobe signal
11	THDAT	Thermal array head serial data
12	E24	24 V ground return
13	E24	24 V ground return
14	+24V	+24 V supply voltage for thermal array head
15	+24V	+24 V supply voltage for thermal array head

CN103 (for CN003 on REC MAIN board)

Refer to “CN003 (for CN103 on REC Power board)” in the “REC MAIN Board” section.

CN104 (for CN201 on REC Key board)

Refer to “CN201 (for CN104 on REC Power board)” in the “REC Key Board” section.

IO ANALOG OUT Board

CN001

Pin Number	Signal Name	Signal Description
1	RSTXD	Data receive
2	RSRXD	Data transmit
3	XRSRTS	Request to send
4	XRSCTS	Clear to send
5	XRSCD	Data set ready
6	RSDTR	Data termination ready
7	+5 V	+5 V supply voltage
8	GND	Digital ground
9	SIG	Data of ECG or trigger signal

CN002

Pin Number	Signal Name	Signal Description
1	EF	Floating ground
2	OUTPUT	ECG or trigger output

CN005

Pin Number	Signal Name	Signal Description
1	R	Red output
2	G	Green output
3	B	Blue output
4	NC	
5	VSYNC GND	Vertical synchronous signal return
6	RGND	Red output return
7	GGND	Green output return
8	BGND	Blue output return
9	NC	
10	HSYNC GND	Horizontal synchronous signal return
11	NC	
12	NC	
13	HSYNC	Horizontal synchronous signal
14	VSYNC	Vertical synchronous signal
15	NC	

CN003

Pin Number	Signal Name	Signal Description
1	NC	
2	NC	
3	NC	
4	NC	
5	NC	
6	NC	
7	SIG	Data of ECG or trigger signal
8	RSTXD	Data receive
9	XRSRTS	Request to send
10	XRSCD	Data set ready
11	NC	
12	NC	
13	NC	
14	NC	
15	NC	
16	+5 V	+5 V supply voltage
17	GND	Digital ground
18	RSRXD	Data transmit
19	XRSCTS	Clear to send
20	RSDTR	Data termination ready

CN004

Pin Number	Signal Name	Signal Description
1	R	Red output
2	RGND	Red output return
3	G	Green output
4	GGND	Green output return
5	B	Blue output
6	BGND	Blue output return
7	VSYNC	Vertical synchronous signal
8	VSYNC GND	Vertical synchronous signal return
9	HSYNC	Horizontal synchronous signal
10	HSYNC GND	Horizontal synchronous signal return

IO CT OUT Board

CN002

Pin Number	Signal Name	Signal Description
1	ECG	ECG analog signal
2	—	—
3	EF	Ground
4	EF	Ground
5	HT	QRS synch trigger signal
6	—	—
7	—	—
8	—	—
9	—	—
10	EF	Ground
11	EF	Ground
12	—	—
13	—	—
14	—	—
15	—	—

CN003

Pin Number	Signal Name	Signal Description
1	R	Red output
2	G	Green output
3	B	Blue output
4	NC	
5	VSYNC GND	Vertical synchronous signal return
6	RGND	Red output return
7	GGND	Green output return
8	BGND	Blue output return
9	NC	
10	HSYNC GND	Horizontal synchronous signal return
11	NC	
12	NC	
13	HSYNC	Horizontal synchronous signal
14	VSYNC	Vertical synchronous signal
15	NC	

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